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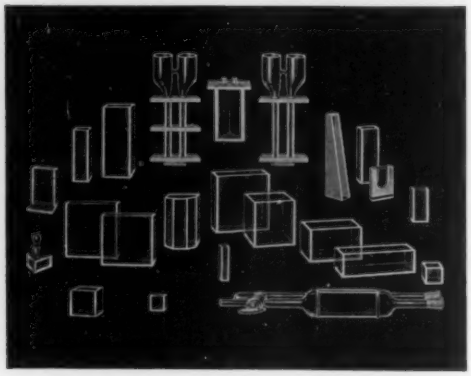

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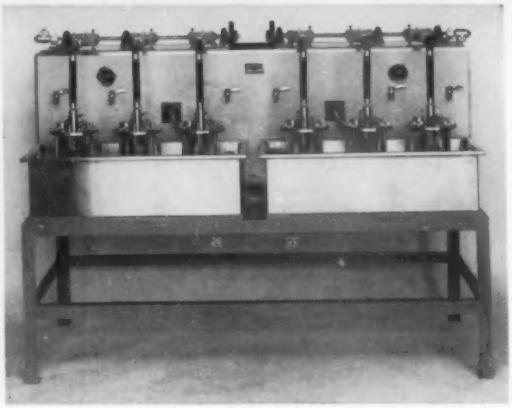

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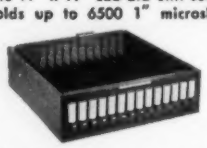

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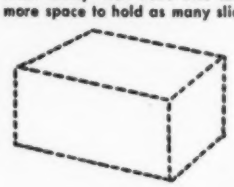

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Science and Loyalty

Early in 1955, The Assistant to the President requested the National Academy of Sciences to advise on the formulation of Federal Government policy dealing with the relations between questions of loyalty and the award of grants and contracts in support of unclassified research [*Science* **121**, 7A (11 Feb. 1955)]. We are pleased to be able to publish in this issue of *Science* the recommendations of the National Academy of Sciences.

Although there is not yet any indication of whether these recommendations will gain Government-wide acceptance, there is encouraging evidence that that may occur. The policies of the National Science Foundation are completely consistent with the Academy recommendations. So, too, are those of the United States Public Health Service. Because of earlier criticisms of that agency, we recently wrote to Surgeon General Scheele to ask about current policies. In his reply, he stated:

"In the past several months the Public Health Service has, within the limits of available appropriations, approved all recommended research and training grant applications on the basis of scientific merit assessed by our advisory groups. We follow a practice similar to that described by the National Science Foundation in its Fifth Annual Report, recently published. In considering matters reflecting on loyalty, the Public Health Service does not knowingly make or continue a grant to any individual who: (1) is a member of the Communist Party as established by admission or by formal proceeding, or (2) avowedly advocates change in the U.S. Government by other than Constitutional means; or (3) has been convicted of sabotage, espionage, sedition, subversive activity under the Smith Act, or a similar crime involving the Nation's security. We agree with the Foundation that the Government should not knowingly support anyone who is, by admission or conviction, disloyal to this country."

Scheele added that the same practice applies to persons who receive funds from grants made to medical schools or other institutions, and that recipients of fellowships and other kinds of direct individual support are asked to sign a loyalty statement.

There are difficult questions involved in the handling of loyalty problems by a scientific agency that is not and should not be an investigative agency. One is the question of what should be done with unevaluated evidence that seems to question the loyalty of a potential or actual grantee. The National Science Foundation and the National Academy of Sciences have met that question by deciding that any substantial derogatory information should be forwarded to the Department of Justice for appropriate action.

There are also principles to be adhered to in making research grants. Two that were endorsed by the AAAS Council in 1954 [*Science* **121**, 249 (1955)] are (i) where questions of national security are not involved—as they are not in unclassified research—the scientific merit of the proposal and of the investigator should be the controlling factors; and (ii) a federal agency should not support a person whose disloyalty has been properly established. The policy of the National Science Foundation and the United States Public Health Service—based on these principles—seems sound and commendable. Other federal agencies will adopt the same policy if the recommendations of the National Academy of Sciences are followed.—D.W.

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Molecular Bases of Parasitism of Some Bacterial Viruses

Seymour S. Cohen

Studies on bacterial viruses have provided many contributions to the theory and practice of virology as a whole. Among these have been the important methodological contributions that permit us to approach the numerous facets of the interactions of host cell and virus —contributions that have opened the way to the systematic study of the multiplication of animal viruses in tissue cultures. In addition to the results with bacterial viruses, which have facilitated the extension of our knowledge to other viruses, results have also been obtained that emphasize the individuality and uniqueness of different groups of viruses. Such results stress the potential pitfalls of careless analogy and extrapolation from one biological system to another. It is the purpose of this article (*1*) to consider a group of bacterial viruses that are designated the T-even bacteriophages, whose early selection for widespread intensive study had been largely a matter of historical accident. The results to be presented reveal an extreme pattern of parasitic behavior that appears to be causally related to the presence of certain unusual chemical conformations. These data are only a small portion of the very extensive biological and chemical data existing on these viruses.

The T-even bacteriophages, T2, T4, and T6, are extreme examples of virulent viruses that can parasitize the bacterium, *Escherichia coli*, prevent its division, and eventually provoke the lysis of the infected cell. It was shown almost a decade ago that infection by T2 and some other phages prevents the synthesis of bacterial enzymes (*2*) and diverts the products of host metabolism to virus synthesis. The shunting of host metabolism is most marked when it is viewed in terms of nucleic acid biosynthesis, for the formation of the host nucleic acids is almost entirely prevented by virus infection. The phosphorus that would normally enter host ribose nucleic acid (RNA) and host deoxyribose nucleic acid (DNA) is diverted to the rapid synthesis of virus nucleic acid (*3*) that is solely of the deoxyribose type.

Since 1947 it has been the major concern of this laboratory to attempt to understand the intimate mechanisms of these phenomena. The early stages of infection that lead to these metabolic events may be briefly summarized as follows. The tadpole-shaped T-even viruses contain DNA in a protein coating. They adsorb tail first to the cell that they infect (*4*) and, in some as yet unknown manner, effect the transfer of their DNA to the bacterial host, leaving the protective protein coat on the cell surface (*5*). The injected viral material is then capable of stimulating the stepwise synthesis and assembly of the important protein and nucleic acid polymers as well as the final product of intact virus. The initial steps of infection also result in the release of inhibited bacterial deoxyribonuclease (*6, 7*), which then participates in the extensive degradation of host DNA.

The author is professor in the departments of biochemistry and pediatrics in the University of Pennsylvania School of Medicine and is a member of the research department of the Children's Hospital of Philadelphia. Dr. Cohen was awarded the 1955 Newcomb Cleveland prize for the work reported in this article, which is based on a paper that he presented 27 Dec. 1955 at a symposium on *Microbiology and Medicine* sponsored by the Section on Medical Sciences during the AAAS Atlanta meeting.

Hexose and Pentose Metabolism of Growing and Virus-Infected Bacteria

To explain the change in pattern of nucleic acid metabolism on infection, it was supposed that infection might cause the inhibition of steps that lead from glucose phosphate to ribose phosphate (*3*). Since these steps were unknown at the time this hypothesis was made, the study of this postulated pathway was undertaken. Oxidative reactions were revealed that lead from glucose-6-phosphate to ribose-5-phosphate via 6-phosphogluconate (*8*). The existence of the intermediate ribulose-5-phosphate between 6-phosphogluconate and ribose-5-phosphate was described in yeast by Horecker *et al.* (*9*) and was subsequently established in *E. coli* as well (*10*). It has been demonstrated that this pathway is indeed of major importance in the formation of the ribose of RNA in growing *E. coli* (*11*).

In *E. coli*, this oxidative phosphogluconate pathway exists side by side with an anaerobic pathway of glucose degradation, the Embden-Meyerhof scheme. In the phosphogluconate route of glucose utilization leading directly from hexose to pentose, the C_1 of glucose-6-phosphate is selectively eliminated as CO_2. During normal growth, both pathways are used, as determined by following the isotope content of the CO_2 that is derived from the utilization of glucose-1-C^{14}. However, under conditions of T-even virus infection, in contrast to normal growth, it was demonstrated that considerably less glucose was metabolized by the oxidative phosphogluconate pathway and more by the Embden-Meyerhof pathway (*12*).

This result was consistent with the observed decrease in synthesis of ribose and the marked increase in synthesis of deoxyribose that was found in virus DNA. An enzymatic mechanism had been observed for the formation of deoxyribose phosphate (*13*) from triose phosphate and acetaldehyde, metabolites that might be expected to be derived more readily from the Embden-Meyerhof pathway than from oxidative phosphogluconate degradation.

However, it has now been observed in collaboration with M. Lanning (*14*) that the deoxyribose formed in host DNA in normal growth of *E. coli* is derived in a manner comparable to that of

Table 1. Origin of ribose and deoxyribose produced in *Escherichia coli* or in T6r+ phage in glucose-1-C^{14} medium. The results are shown as ratios of counts per minute of C^{14} per micromole of these sugars or isolated derivatives (*13, 14*).

Nucleic acid	Ribose/ glucose	Deoxy-ribose/ glucose
E. coli nucleic acids	0.247 ± 0.047	0.229 ± 0.023
T6r+ DNA		0.496 ± 0.078

the ribose of RNA by a route involving the selective loss of the C_1 of glucose. These results are given in Table 1. They are consistent with the possibility that in this system deoxyribose is predominantly derived from ribose, and they are apparently incompatible with the known enzymatic route for the synthesis of the deoxypentose phosphate. However, under conditions of virus infection, a new path for deoxyribose formation appears to be used, if it is assumed that the mechanism of formation of ribose via phosphogluconate is substantially unchanged. As can be seen from Table 1, the route for synthesis of deoxyribose in virus infection involves a much greater conservation of the C_1 of glucose and is consistent with a possible major utilization of the Embden-Meyerhof scheme in the formation of deoxyribose phosphate from triose phosphate and acetaldehyde.

Thus alternative paths exist in *E. coli* for the metabolism of glucose to the ribose and deoxyribose of the nucleic acids, and the degree to which each is used is profoundly altered by T-even virus infection. However, it has been possible to show that a depression of the utilization of the oxidative phosphogluconate pathway as a result of infection is not caused by an inhibition of the enzymes of this pathway (*15*). Substrates, such as gluconate, that are phosphorylated to intermediate metabolites of this route and that must be metabolized by the phosphogluconate pathway can nevertheless be used in infected bacteria for the synthesis of viral DNA. It was concluded, therefore, that the control of the balance of the pathways of glucose utilization is determined at some metabolic level apart from the enzymes that exist in the pathways themselves.

Unique Viral Constituent

A clue to the nature of this control appeared as a result of studies on the base composition of the nucleic acids of the T-even phages. In collaboration with G. R. Wyatt, it was found that a new unique pyrimidine, 5-hydroxymethyl cytosine (HMC) completely replaced cytosine, a base that had previously been observed in all other nucleic acids studied, including those of *E. coli* RNA and DNA (*16*). Furthermore, this new pyrimidine or HMC has not yet been observed in any other virus, bacterium, plant, or animal. Its distribution appears to be absolutely unique. The resulting difference in the base composition of host and virus nucleic acids may be used to distinguish the formation of virus DNA from host DNA in infected bacteria (*17, 18*).

Fragments of host DNA, which are degraded at least in part to nucleosides, can be utilized for the synthesis of virus DNA. More specifically, as shown in studies with L. L. Weed, the cytosine of host DNA can be converted to the HMC and thymine of virus DNA (*19, 20*), whereas the thymine of host DNA is used to make viral thymine but not HMC. These relationships are depicted in Fig. 1. This result and the obvious requirement of cytosine for the synthesis of host RNA and DNA have led to the hypothesis that in T-even virus infection the formation of hydroxymethyl cytosine traps cytosine (more likely cytosine derivatives), thereby limiting the availability of the latter metabolites that are essential to the synthesis of host components.

It has further been demonstrated that the β carbon of serine may serve as an important source of the hydroxymethyl group of HMC (*19*). More recently it has been observed that the hydroxymethyl group of S-hydroxymethyl homocysteine does not fulfill this function when it is added exogenously to infected bacteria (*21*). The methyl groups of thymine (*19*) and methionine (*21*) both appear to be essentially incapable of conversion to the $—CH_2OH$ level in these systems. The details of the mechanism whereby cytosine derivatives are converted to HMC are not yet known. This knowledge is crucial to an understanding of the manner in which infection initiates and compels the critical hydroxymethylation.

Additional data that support the concept that the addition of the hydroxymethyl group to form HMC is the molecular basis for the competitive winning out of viral products are derived from studies on the utilization of HMC and its derivatives (*22*). In experiments with isolated enzyme systems, growing and infected *E. coli*, and mutant organisms requiring pyrimidines for growth, it was observed that both HMC and 5-hydroxymethyl uracil are quite inert under conditions in which cytosine is deaminated, incorporated, or utilized for growth. The deoxyriboside of HMC is also relatively inert, being far more slowly deaminated by deoxycytidine deaminase or otherwise metabolized than is cytosine deoxyriboside. Thus the conversion of cytosine to HMC has the attributes of a one-way stream in which hydroxymethylation irreversibly traps the cytosine. These results are consistent with the observation that bacteria may multiply viruses that contain cytosine or HMC, but never those that contain both simultaneously. It will be of considerable interest to determine the extent of synthesis and turnover in infected cells of cytosine nucleotides, which, in addition to their structural role in the nucleic acids, have also been implicated in phospholipid metabolism.

Virus Survival and Hydroxymethyl Cytosine Glucoside

Another role for HMC was revealed as a result of an effort to isolate the HMC deoxyriboside by the usual enzymatic methods involving deoxyribonuclease and a phosphatase (*22*). In contrast to the behavior of thymus DNA, which is almost completely degraded to deoxyribosides by successive treatment with these enzymes, the DNA of the T-even viruses is degraded more slowly and less completely. Only about 70 to 75 percent of the total phosphorus is released as inorganic P, and very small amounts of HMC deoxyriboside are found among the nucleosides. Indeed, it is precisely HMC that is concentrated among the enzyme-

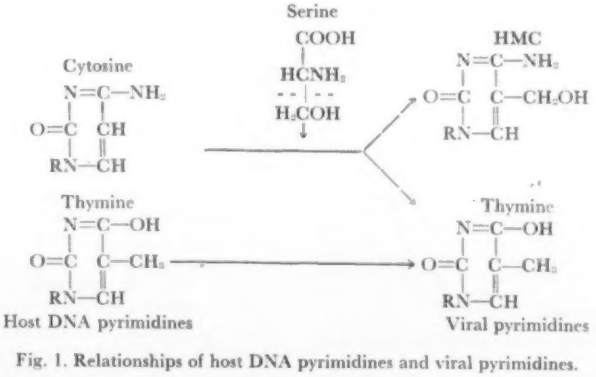

Fig. 1. Relationships of host DNA pyrimidines and viral pyrimidines.

resistant mixture of residual polynucleotides. Acid hydrolysis of viral DNA permitted the HMC deoxyriboside to be released by the action of phosphatase. The presence of HMC in viral DNA in some manner permitted an organization of the DNA that protected critical nucleotide diester linkages from enzymatic degradation. It was suggested that this resistance to enzymatic degradation, under conditions of infection in which host DNA was fragmented, is a factor that facilitates the survival of the genetic material of the virus injected into the host. Insofar as the degraded products of host DNA are further trapped after hydroxymethylation in an enzyme-resistant virus DNA, this also contributes in deciding the relative dominance of competitive nucleic acid systems in an infected cell.

The molecular nature of this relative resistance is now explicable in terms of the discovery by Volkin (*23*) and by Sinsheimer (*24*) of glucose as a glycosidic substituent of the hydroxymethyl group of HMC, as presented in Fig. 2. When the DNA of T2r$^+$ was hydrolyzed with nuclease and diesterase, small amounts of two HMC nucleotides were obtained (*24*), only one of which contained glucose. The HMC nucleotide with a free hydroxymethyl group was readily dephosphorylated by phosphatase; that in which the hydroxymethyl group is bound to glucose is markedly resistant to this enzyme.

The presence of glucose in DNA is as unique in the T-even viral DNA as is the presence of HMC. Thus other viruses contain cytosine and therefore lack the hydroxymethyl group as a site of attachment for glucose, which helps to stabilize T-even viral DNA. How, then, do the nucleic acids of these other viruses compete for dominance in the cells that they infect? With some temperate viruses, which produce lysogeny, infection does not result in nuclear disintegration. The DNA of the virus appears to establish a symbiotic relationship with the genetic substance of its host that permits mutual survival. Nevertheless, there are some virulent cytosine-containing viruses that can kill and lyse bacteria

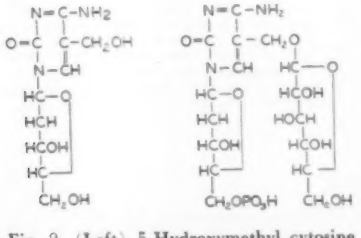

Fig. 2. (Left) 5-Hydroxymethyl cytosine deoxyriboside; (right) 5-glucosyl hydroxymethyl cytosine deoxynucleotide.

even as do the T-even phages. Since their respective deoxyribose nucleic acids must also survive and compete successfully in the cells that they infect, it must be supposed that they have different, as yet unknown, structural modifications that fulfill these functions. Indeed, the existence of any pathogenic virus implies the existence of survival and competitive mechanisms whose natures are barely beginning to be explored.

Glucose Contents of r$^+$ and r Viruses

The T-even phages that are found most commonly in nature are designated as r$^+$ and are distinguished by the characteristically small turbid plaques that they produce in a bacterial film on nutrient agar plates. This plaque morphology is explained by the fact that superinfection of r$^+$-infected bacteria by a T-even phage causes temporary lysis inhibition (*25*). The r$^+$ phages mutate to r viruses that form large clear plaques, and an apparently limitless series of such r mutants may be obtained from any r$^+$ phage. Lysis inhibition can be accomplished as a result of superinfection with either r$^+$ or r viruses. Although the biochemical nature of lysis inhibition is obscure, it is possible that the mechanism can be interpreted in part in terms of "superinfection breakdown." Thus it has been observed that the DNA of the superinfecting virus of the r or r$^+$ types may be prevented from making genetic contributions to virus multiplication and may be actively degraded (*26*). It may be suggested, then, that lysis inhibition may be effected by a DNA degradation product.

A number of physiological and analytic studies had been made of mutant pairs of T-even viruses—that is, T2r$^+$ and T2r, T4r$^+$ and T4r, and T6r$^+$ and T6r. Significant differences relevant to the nature of the difference between r$^+$ and r phages were not observed in studies of the adsorption rates, of the rates of nucleic acid and protein synthesis, of the course of multiplication, and so forth (*27*). Furthermore, in detailed analyses of the various deoxyribose nucleic acids from the 6 genetically distinct phages, it was determined that the base compositions of all these nucleic acids were substantially identical (*16*). It appeared necessary to infer at that time that, if the structure of the DNA controlled the genetic bases of mutational differences among these phages, the mutational differences arose either from quantitative differences too small to be detected by existing analytic methods or from differences in the sequential order of the nucleotides.

At the present time, lysis inhibition has been observed only with the T-even viruses—that is, with viruses containing

Table 2. Glucose/deoxyribose ratios of preparations of r$^+$ and r viruses and of DNA preparations of r viruses. A glucose to HMC ratio of 1 would yield a glucose to deoxyribose ratio of 0.17. The numbers in parentheses in column 1 indicate the number of preparations studied.

Strain	Media	Ratio
T2r$^+$ (5)	all	0.12–0.15
T4r$^+$ (8)	all	0.20–0.23
T6r$^+$ (5)	all	0.17–0.25
T2r (5)	broth	0.19–0.21
T4r (3)	broth	0.31–0.61
(3)	synthetic	1.39–1.74
T4r DNA (2)	broth	0.52, 0.52
T6r (4)	broth	0.29–0.35
(7)	synthetic	0.52–1.12
T6r DNA (4)	all	0.34, 0.35, 0.37, 0.62

HMC and glucose attached to the hydroxymethyl group. As a working hypothesis, it was supposed that the presence or absence of the HMC glucoside might be directly related to the existence of lysis inhibition. The data presented in subsequent paragraphs stem from our efforts to test this hypothesis. As a consequence of this hypothesis, it appeared possible that r$^+$ strains might differ among themselves and from r strains with respect to the average amount of glucose bound to HMC. The properties of our r$^+$ and r strains and isolation by differential centrifugation have been described elsewhere (*27*). Lysates of each strain have been made in a single multiplication cycle in multiply infected cells in nutrient broth or in a glucose-mineral salts medium. More than 40 preparations of virus concentrates have been obtained and analyzed, of which 17 have been of the r$^+$ type.

The anthrone reaction was modified to permit analysis of glucose in the presence of the deoxyribose in DNA. On heating glucose, DNA, and the anthrone reagent (*28*) at 70°C for 15 minutes, only purine deoxyribose and glucose react, giving absorption maxima at 475 and 625 mμ, respectively. Although reactions of mixtures of glucose and deoxyribose give spectra that are sums of the spectra of the individual components, components of the phage preparation affected the spectra at the absorption maximum of deoxyribose. This component was therefore estimated by the diphenylamine reaction, and the hexose contents (calculated as glucose) of the preparations were estimated after correcting the absorption at 625 mμ for that due to deoxyribose at that wavelength.

The glucose-to-deoxyribose ratios of the r$^+$ strains are presented in Table 2. It was found that preparations of T2r$^+$ contain less glucose than HMC, and it may be concluded that at least 20 per-

cent of the HMC nucleotides do not contain glucose.

This result is consistent with the observed liberation of glucose-free HMC nucleotides from T2r+ DNA as a result of diesterase action (*24*). On the other hand, all preparations of T4r+ and T6r+ contained at least one molecule of glucose per hydroxymethyl group, a result consistent with the work of Volkin (*23*) with T4r+. The existence of a G/DR somewhat in excess of 0.17 suggests the desirability of determining whether some polyglucose chains may not be present in these viruses. In any case, whereas it is not possible to distinguish preparations of T2 from T4 and T6 on the basis of HMC content, reproducible differences have been found with respect to the amount of glucose found in the r+ virus preparations (*29*).

All r phage preparations analyzed possessed G/DR ratios that considerably exceeded the highest G/DR ratio obtained for the homologous r+ strain as seen in Table 2. Two types of r preparations were found, however. When the r phages were isolated from broth lysates, the G/DR ratios were on the average about 50 percent higher than the average of all preparations of the homologous r+ phage. No preparation of r phage was obtained that had a G/DR ratio less than 20 percent higher than that of any homologous r+ phage preparation. When the r phages were isolated from glucose-containing synthetic media, a range of relatively high G/DR ratios was obtained, much higher than the ratios for the same phages obtained from broth. When T4r and T6r phages derived from broth lysates have been used to infect bacteria in glucose media, preparations of the derived isolated r phages then possessed the higher ratios noted.

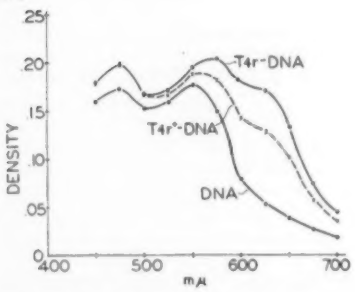

Fig. 3. Spectra of various DNA samples in the anthrone reactions: ●——● thymus DNA, 200 μg; ×——× T4r+ DNA, 234 μg, G/DR = 0.26; ○——○ T4r DNA, 194 μg, G/DR = 0.52.

In order to determine the significance of both the high G/DR ratios and their variability, two types of study were undertaken. Using the presence of RNA in the virus preparations as evidence for bacterial contamination, it was found that of 11 preparations studied, six preparations with the highest G/DR ratios were undoubtedly so contaminated. However, RNA was not detected in five preparations of r viruses in which the G/DR ratios were approximately 50 to 100 percent higher than those of the homologous r+ phages.

The analysis then turned to the study of isolated DNA to see whether the high glucose content could be obtained with these fractions of the whole phage. Preparations of r+ and r DNA were isolated by the urea method. Two have been isolated from T4r and four from T6r. The G/DR ratios of the former were 0.52 and 0.52; those of the latter were 0.62, 0.37, 0.35, and 0.34. It may be noted that the final precipitation of these polymers was accomplished by adding ethanol to the deproteinized solution containing 6*M* urea and 2*M* NaCl, the fibrous sodium nucleate being collected at 70 percent ethanol. These fibers were wound around a rod, and the adherent liquid was expressed. The fibers were then rinsed and dried. The G/DR ratios of the isolated preparations were similar to those of the preparations from which they were derived (*30*).

For example, the DNA of a T4r preparation (G/DR = 0.61) was isolated as described and found to have a G/DR ratio of 0.52, as presented in Fig. 3. Thus the DNA and hexose in excess of 1 glucose per hydroxymethyl group were coprecipitated in a fibrous strand by 70-percent ethanol. In addition, this material was partially degraded with deoxyribonuclease and caused to migrate in an electric field on paper. Sections of the single, somewhat broadened band that had moved several centimeters away from the origin were eluted and analyzed. The eluate of the front half of the material possessed a G/DR ratio of 0.42; the ratio of the back half was 0.62.

Although these data suggest a chemical relation of the extra glucose to the DNA of the r phages, it may be pointed out that the properties of the r phages increase the difficulty of their purification. Lysis of r-infected cells is more extensive than that of r+-infected cells, tending to degrade the bacterial debris to a size that may be more closely comparable to that of the phages than is debris from an r+ lysate. Such contaminating debris may be expected to liberate polysaccharide in the procedure used for the isolation of phage DNA, and conceivably such polysaccharide may precipitate with the DNA. Accordingly, experiments have been begun on the isolation of glucose-containing fragments of the DNA of the r phages in an effort to clarify the structural relationships of the extra glucose found in these preparations.

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30. The hexose released by hydrolysis of 10-mg samples of DNA from T6r+ and T6r has recently been found to be glucose alone, using the methods described by Volkin (*23*). The yield of glucose from T6r DNA was greater than that from T6r+ DNA, the relative yields being in essentially the same ratio as those observed by means of the anthrone reaction.

Believing, as I do, in the continuity of nature, I cannot stop abruptly where our microscopes cease to be of use. Here the vision of the mind authoritatively supplements the vision of the eye.—JOHN TYNDALL.

Radioactive Fallout and Radioactive Strontium

W. F. Libby

The radioactivity that falls out of the atmosphere after the explosion of a nuclear weapon is called the radioactive fallout. In the ordinary atomic bomb, for example, for each 20,000 tons of TNT equivalent of explosive energy, about 2 pounds of radioactive materials are produced. In these 2 pounds are some 90 different radioactive species varying in lifetime from a fraction of a second to many years. This mixture of radioactivity decreases in radioactivity in such a way that for every sevenfold increase in age, the total radioactivity is decreased tenfold. Thus the radioactivity by 7 hours after the explosion has decreased to one-tenth the radioactivity of 1 hour, and in 49 hours to 1/100, in 2 weeks to 1/1000, in three months to 1/10,000, and so forth.

The conditions of fallout are largely determined by the amount and type of material vaporized into the fireball of the bomb itself. A bomb fired in the air contributes such a relatively small amount of matter to the cloud that the particles formed after dissipation of the enormous energy released are of necessity very tiny and therefore very slow in settling. The result is that most of the radioactivities are expended in the air and the area over which the fallout occurs is rendered very large indeed, extending to the ends of the earth in minute although detectable amounts.

A bomb fired on the surface of the earth, however, may have an appreciable portion of its radioactivity reprecipitated within relatively short distances, while bombs fired beneath the surface of the earth may place essentially no fallout radioactivity in the atmosphere. Therefore, the question of the area of contamination to be expected from nuclear weapons cannot be answered categorically without specifying the degree of contact of the fireball with the surface of the earth and probably also specifying the characteristics of this surface. Obviously water would differ considerably from soil in its ability to precipitate radioactive fallout. The coral in the southern Pacific islands that are used for the larger United States weapons tests will under the great heat decompose to form calcium oxide, which will then rehydrate to form calcium hydroxide, which in turn will absorb carbon dioxide to form a crust of calcium carbonate. Obviously such a complicated series of chemical reactions will make the fallout particles from the great tests at Eniwetok differ from what would be observed if the same weapons had been fired over ordinary sand or granite. We cannot imagine all of the details in which the nature of the soil will affect the local fallout, but it is clear that the effects will be substantial.

In the weapon test operations, great care is taken to insure that no danger results from fallout. Criteria are used that are meant to insure that this is so. However, it is well to note that it is from the test operations that we have learned what we do know about the problem of civilian defense against fallout. We must speak of test experience, for it is the only source of experimental information about the phenomena of radioactive fallout.

The radioactivities resulting from the burst of a nuclear weapon can be classified as follows: (i) radioactivities induced in the environment and (ii) products dependent directly on the nature of the weapon. The environment can be made radioactive only by neutrons, but all nuclear weapons involve large numbers of neutrons, some of which are certain to escape into the surroundings.

Radioactivities Induced in the Environment

Taking air bursts first, our problem is: What do neutrons do to air? The answer is simple. They make radioactive carbon, C^{14}, which has a half-life of 5600 years. Fortunately, this radioactivity is essentially safe because of its long lifetime and the enormous amount of diluting carbon dioxide in the atmosphere. The cosmic rays themselves make neutrons, which, of course, make radiocarbon. In fact, the earth has on its surface a total of 80 tons of radiocarbon from the cosmic radiation. Now, since each neutron forms one C^{14} atom of mass 14 times the neutron's mass, this corresponds to 5.2 tons of neutrons, and we see that this enormous number of neutrons would have to be produced and escape in order that nuclear weapons would just double the feeble natural radioactivity of living matter due to radiocarbon. Such an increase would have no significance from the standpoint of health. The atmosphere itself contains only 1.5 percent of the total carbon with which the cosmic-ray-produced radiocarbon is mixed, the main part being dissolved in the sea, so we expect that nuclear weapons could produce a short-range rise in the radiocarbon content of the carbon dioxide in the atmosphere, which later would decrease as the atmospheric carbon dioxide mixed with the sea. Therefore, only 1.5 percent as many neutrons would be required to double the natural radiocarbon content of atmospheric carbon dioxide for this time before mixing with the sea could occur, or about 78 kilograms or 170 pound of neutrons. To orient ourselves, the 20,000-tons-of-TNT-equivalent atomic weapon involves the fission of 1 kilogram of uranium or plutonium and the liberation of about 10 grams of neutrons. If all these neutrons escaped into the atmosphere, it would obviously require 7800 such weapons to double the radiocarbon content of the atmospheric carbon dioxide even with no mixing with the sea, and about 520,000 with complete mixing. These correspond to explosive energies of 156 and 10,400 megatons of TNT, respectively, if all neutrons formed escaped. A reasonable escape figure might be 15 percent, so we can expect that nearly 1000 megatons of fission would be necessary just to double the atmospheric radiocarbon content, and that about 66,000 megatons would be necessary for the same effect on a long-term basis.

The interchange between the atmosphere and the sea water, which is constantly taking place, would deplete and remove the excess radioactive carbon dioxide. Now it is known from measurements of the radioactive hydrogen, tritium—which is also made in the atmosphere by the cosmic rays—that this interchange is slow. In fact, we learn that the radioactive water that is formed by the burning of the tritium made by the cosmic rays is not diluted by more than the top 100 meters or so of sea water in its lifetime of about 18 years. The carbon dioxide dissolved in this water is about equal to the total in the

The author is a member of the U.S. Atomic Energy Commission. This article is based on a speech given at Northwestern University, Evanston, Ill., 19 Jan. 1956.

air. In other words, a dilution by more than the twofold that corresponds to the dissolved carbon dioxide in the top 100 meters of ocean water would take longer than 18 years. However, the dilution by this factor of 2 would occur essentially immediately within a matter of weeks or months. Therefore, we would have to double our estimates for even the short time scale activation of the atmosphere to reach the enormous figure of 2000 megatons of fission required. Thermonuclear weapons, of course, also involve neutrons. For a given energy release, they produce somewhat more neutrons than fission weapons; however, the order of magnitude of atmospheric activation would not be greatly different. So our estimates apply to all nuclear weapons. The essential point is that the atmosphere is difficult to activate and the activities produced are safe. In addition to carbon-14, there are a few others produced in low yield; they include tritium and very short-lived products, but none is produced in sufficient amounts to be hazardous.

For weapons fired on the surface, the activation of the surface materials is a possibility, but in general it appears that most of the neutrons form stable isotopes and that the amount of radioactivity produced, at least with ordinary surface materials, is relatively small. The principal radioactivities produced by nuclear weapons are produced in the weapons themselves, and not in the environment.

Radioactivities Produced in Weapons

Turning now to the radioactivities naturally produced in nuclear weapons themselves, probably the most important is radioactive strontium, which has a half-life of 28 years. The first reason this is so important is that strontium is chemically similar to calcium, which is one of the main mineral constituents of the body. Bone consists principally of calcium phosphate, and for this reason radiostrontium, like calcium, is deposited in the bone. The amounts of ordinary nonradioactive strontium naturally present are so small that the radioactive strontium will follow ordinary calcium into the body. The second reason that radioactive strontium, Sr^{90}, is an important fallout radioactivity is that it has a long but finite lifetime—28 years half-life, 40 years average life—and thus has a persistent effect. Third, because of its bone seeking property, it stays in the body a long time. Fourth, the probabilities of body ingestion can be high. Finally, the fifth reason for its importance is that strontium-90 is produced in high yield in the fission reaction—about 4 or 5 percent of all fissioning atoms yield this isotope.

In order to orient ourselves about this, let us consider the maximum permissible concentration recommended by the National Committee on Radiation Protection for AEC workers for radiostrontium —1 microcurie for the standard man, whose body is taken to contain 1000 grams of calcium in total. The maximum permissible concentration is of course well below any level at which one would expect any damaging effects to appear. On the basis of experiments with animals, statistically observable increases in the number of bone tumors *should not* be expected to appear at *less than* 10 times this level. As we go above this figure, the chance for bone tumors occurring increases rapidly so that the likelihood of bone cancer with 30 to 40 times that figure is appreciable.

Intake of Strontium-90

Let us consider in some detail the mechanism by which this most important fallout radioactivity produced in nuclear weapons might be expected to enter the human body. The first point is that from the point of view of fallout there are essentially two classes of nuclear weapons—the high-yield megaton weapons and the lower-yield kiloton weapons. All nuclear weapons produce atomic clouds that rise to heights dependent on the energy released, and the clouds from the megaton class of weapons rise rapidly up through the tropopause and pass into the top layer of the atmosphere, which we know as the stratosphere. This part of the atmosphere is essentially isolated from the lower layer in which we live, the troposphere, and where all of our normal winds, storms, and so forth, occur. Therefore, radioactivity produced in megaton weapons is placed largely immediately in the stratosphere, while the smaller kiloton weapons produce clouds that in general do not reach into the stratosphere, but stop near the tropopause—the imaginary boundary between the stratosphere and troposphere—and have the bulk of their radioactivity left in the troposphere.

In the troposphere where rain occurs, any particulate matter will be washed down in a period of days or weeks. It is easy to show, for example, that 0.1 inch of ordinary rainfall will probably remove essentially completely all particulate matter except for that which is so small as to be almost of molecular dimensions. In other words, for 0.1 inch of rainfall one can be quite certain that the air between the layer in which the rain originates and the ground is washed clean of fallout activity, except for the minute fraction that may be so small that it moves with the air out of the way of the falling raindrops as they make their way toward the earth; and even this tiniest fallout material is likely to be precipitated also, for it will migrate rapidly by molecular-type motion and in this manner is likely to absorb itself on other particulate material and so be rained out. For these reasons, tropospheric radioactive fallout does not stay in the atmosphere for more than a matter of weeks. It may make two or three trips around the earth in a given latitude before being entirely removed, but its lifetime in the atmosphere will be a matter of weeks.

This is in very sharp contrast to the material that is placed in the stratosphere by megaton weapons; this material appears to stay there for a matter of years. Perhaps 10 years is a good average, at least for the weapons fired to date. It is well to bear in mind that this conclusion may be dependent on the nature of the material carried up in the cloud, but our present experience indicates that the fallout from megaton weapons that does not occur essentially in the first few hours or days, and is therefore deposited mainly locally, is deposited only at a very slow rate corresponding to an average time in the stratosphere of about 10 years. As a result of this long residence time in the highest layers of the atmosphere, the winds mix and distribute the radioactive material broadly over the earth and one finds, when the fallout does finally find its way down into the troposphere where the rain and snow wash it out, that the rates of precipitation are relatively uniform over the entire earth's surface.

Returning now to radiostrontium—at the rate of 1 kilogram of fission per 20 kilotons of TNT equivalent, 2 megatons of fission energy would be equivalent to very nearly 1 millicurie of strontium-90 per square mile of the earth's surface, or about 79 disintegrations per minute, per square foot of the earth's surface. The average soil of the earth has about 20 grams of calcium that is in a form available for plant metabolism in the top 2.5 inches for each square foot of area. Now, recalling the maximum permissible concentration level of 1 microcurie per standard man and noting, as will be shown later, that in order that this concentration not be exceeded, the topsoil of the earth should not contain any more radiostrontium than would correspond to 10 times the concentration in the human body that is just permissible—that is, 1 microcurie per 1000 grams of calcium, or 2200 disintegrations per minute, per gram of calcium—we find that 11,000 megatons of fission energy would produce this average level of radioactivity. Actually, as I will indicate, there can be a concentration of strontium-90 in the soil about 10 times greater

than the recommended maximum permissible concentration before one would expect a man living in such an environment to accumulate a maximum permission concentration. The afore-mentioned 11,000 megatons of fission energy would yield a strontium-90 content in human beings just equal to the maximum permissible concentration (MPC); at less than 10 times this value, or below 110,000 megatons energy equivalent, statistically observable incidence of bone tumor should not appear; but at 30 to 40 times the MPC, or 330,000 to 440,000 megatons, the likelihood of untoward effects would be appreciable. Even the lowest of these figures is very far in excess of the total energy released to date.

Kinds of Fallout

High-yield weapons fired near the surface have a portion of their activity deposited in and on particles large enough to fall out in the first few hours or days. Thus we have three kinds of fallout from high-yield weapons.

1) The first, or local, is due mainly to large-sized particles. This may cover a considerable area depending mainly on winds. In the 15 February 1955 release of the Atomic Energy Commission that described the experience in the Marshall Islands in the Castle test series in the spring of 1954, some 7000 square miles were described as being contaminated by this type of fallout.

2) The second fallout from the high-yield weapons is that portion which resides on the small particles, but which never reaches the stratosphere and thus stays in the troposphere until it is carried down by rainfall or settles out. There is thus a band of fallout in the same general latitude as the test site; the material may circle the earth two or three times before it is precipitated, but it does fall out within the first few weeks.

3) However, a large part—half or more depending on firing conditions—of the radioactive yield from high-yield weapons resides in the third category, which is the fallout that occurs from the stratosphere itself. Of course, some of the large local fallout may form particles which were lifted into the stratosphere, but which were so large and so bulky that they fell out rapidly anyhow. The finely divided material that reaches the stratosphere apparently stays there for years in the main. A slow leakage through the tropopause into the troposphere occurs—apparently something like 10 percent per year descends. Measurements of the strontium-90 content of soils, rain and snow, and biological materials on a worldwide basis have all shown that strontium-90 fallout occurs all over the world at rates that are not very dissimilar from one another, except that there is a tendency in the middle latitudes in which the tests are conducted for an extra fallout, presumably of the afore-mentioned tropospheric variety. Since the completion of the Castle series of tests two years ago, this world-wide rate of fallout has approximated 1.5 millicuries of radiostrontium per square mile, per year. We thus see that radioactive fallout from the stratosphere is a very slow process. This is very fortunate indeed, since the high-yield weapons thus have a major part of their radioactivity dissipated in the atmosphere in a harmless way if they are fired in the air or on the surface.

The fallout apparently occurs in the final step by a washing down of the tropospheric air by rain together with direct falling. The radiostrontium descends from the stratosphere into the troposphere by the processes of diffusion and falling, and is then caught up by the tropospheric weather and in a matter of a few days is deposited. Reasonable estimates for the middle latitudes indicate that the average life in the troposphere is about 1 week.

Deposition of Strontium-90

The radiostrontium comes down mainly in raindrops although fine morning mists and fogs may be particularly effective in this regard also, as well as surface contact and direct falling. It descends on the foliage and on the soil. That fraction of it which falls on plant leaves has a good chance of being absorbed directly into the plant—much in the way that most modern leaf fertilizers operate. The Eniwetok tests were conducted on coral islands and as a result their fallout may be largely water-soluble. In any case, direct measurements of the radiostrontium content of alfalfa and other crops showed them to be appreciably higher in radioactivity than the soils on which they grew, strongly indicating that a leaf assimilation mechanism is important. The rain falls and carries radioactivity, but when it runs off to the rivers and the seas it is nearly pure because of the action of the soil in absorbing the fallout, so that rivers are essentially free from radiostrontium. Lakes and reservoirs have a content that corresponds approximately to their surface areas only. The radiostrontium is absorbed in the top 2 or 3 inches of soil and held there very tenaciously. Plowing, of course, buries it more deeply, but it appears that in unplowed soil the radiostrontium does not move in a matter of 2 or 3 years.

The researches on radiostrontium conducted by the Atomic Energy Commission have been extensive. The AEC has sampled soils on a world-wide basis and submitted the samples for analysis of radiostrontium content to the Health and Safety Laboratory of the New York Operations Office of the Atomic Energy Commission, the Lamont Geological Observatory of Columbia University, and the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. Direct fallout collected on gummed papers, milk and cheese, alfalfa, animal meat and bone, and even human bodies has been extensively studied. On the basis of the information so obtained, it is possible to say unequivocally that nuclear weapons tests as carried out at the present time do not constitute a health hazard to the human population insofar as radiostrontium is concerned, and it is believed with good reason that radiostrontium is likely to be the most important of the radioactivities produced. It is well to note that since radiostrontium is assimilated in the bones it constitutes essentially no genetic hazard, for its radiations do not reach the reproductive organs.

The milk and cheese radiostrontium content is not as high, relative to that of the grass which the cows eat, as one might expect. There appears to be a discrimination against the fallout material such that the calcium in milk and cheese is roughly one-fifth to one-tenth as radioactive with radiostrontium as the grass that the animals eat. There are various possible physiological explanations of this, and the conclusion itself may not be completely certain, but the data available to date indicate this to be true. In addition, the plant uptake of radiostrontium from soil does discriminate somewhat against radiostrontium as compared with calcium. The calcium taken up from the soil into the plant has in general about one-half the radiostrontium content that the soil calcium has. These two results protect the human population against ingestion of radiostrontium, since milk and cheese are the principal sources of calcium in the human diet. We find, therefore, that the radiostrontium content of human bodies is the lowest of all animals measured and is lower than the average soil and the average foliage by tenfold. The Sr^{90}-to-calcium ratio in young people—whose bones are still forming—corresponds to about 1/1000 of the maximum permissible concentration recommended for adults—1 microcurie per standard man containing 1000 grams of calcium. The average soil in the United States contains about 10 times more, whereas abroad the radiostrontium content in other areas of the world not subject to the local test fallout is about one-third of that for the United States.

The surface air itself contains radiostrontium due to the fallout from the stratosphere and corresponding to the average time between rainstorms in which it can collect. Filtration of air at sea level discloses radiostrontium on filters if the filters are fine enough, even in periods when bombs are not being tested; thus the only fallout is from the stratosphere reservoir from the high-yield weapons. Measurements in the antarctic on snow samples collected there show that the fallout rate in January and February 1955 was comparable with that observed in the middle latitudes.

Conclusion

Finally, although the main part of the radioactivity from high-yield weapons fortunately dissipates in the stratosphere, the small but very significant part that falls out within a few hundred miles of the site of the explosion for weapons fired on the surface constitutes a very real hazard and nothing I have said should be interpreted otherwise. The weapons tests are conducted with great attention to this and the other dangers and every effort made to protect against misadventure. What we have learned from the studies I have described—which by the way have been conducted under the name Project Sunshine—is that these local precautions should be entirely adequate and the worldwide health hazards from the present rate of testing are insignificant.

Loyalty and Research

Report of the Committee on Loyalty in Relation to Government Support of Unclassified Research

The Federal Government now sponsors a substantial part of the total research activities of the nation. The major portion of this sponsorship relates to military defense and leads to information which, were it loosely guarded, might to some degree jeopardize the security of the United States. To protect the national interest, the Government has instituted measures designed to exclude from all projects involving such information persons that may be suspected of secret subversion including espionage, of serious moral defects of character, of indiscretion, or of vulnerability to blackmail. These measures are imposed upon each contractor and accepted voluntarily by each individual worker as a condition of employment. They are bulwarked by the vast Federal machinery of investigation and moderated or controlled through boards of review. Projects of this character are referred to as "classified" or "sensitive" and both their prevalence and the conditions that govern them appear to be a reflection of the times in which we live.

But above and beyond its present huge commitment to classified research the Government invests also in research of a more fundamental character in the physical, biological and other sciences through grants and contracts to universities, hospitals and other nonprofit institutions. By their inherent nature the results of such investigations are unlikely to affect directly our immediate military security. Nevertheless, this great body of knowledge, when published, disseminated, and taught in our universities, becomes the basis upon which scientists and engineers will build the economic welfare and military strength of our country. This is the national investment in the future of science and the very life line of our continuing growth, and it is incumbent upon the Government to discover and maintain those conditions under which it will best thrive.

In the administration of grants and contracts for unclassified research, which by its very definition has no implication of secrecy, the government has refrained by and large from initiating inquiries into the personal character of those carrying on the research. There have, however, been incidents when doubts have been raised with respect to the loyalty of specific individuals. Such cases will in all probability continue to occur from time to time. The question then arises as to the extent to which the Government is obligated to ascertain the loyalty of a scientist—not in the employ of the Government—who utilizes public funds on a project that clearly requires no security classification.

To assist in the establishment of policy in these matters, Governor Sherman Adams on behalf of the President of the United States invited the National Academy of Sciences on January 11, 1955 to counsel with the Government. He pointed out in his letter that the Academy acts under Congressional charter "to advise the Government in the formulation of policy to the end that the scientific resources of our country may be fully and effectively utilized." Governor Adams stressed moreover the tremendous importance which he attached to the handling of this problem so as to avoid misunderstandings between scientists and the Government which might impair the cordial relationships which are so vital to the national welfare, and added that "it is equally important that people outside the scientific community understand the nature of the problem and that their confidence in the Government's handling of this important phase of the public trust be maintained."

On January 28, 1955 Dr. Detlev W. Bronk, President of the Academy, accepted the task on behalf of the Academy

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The Committee on Loyalty in Relation to Government Support of Unclassified Research was appointed by Detlev W. Bronk, president of the National Academy of Sciences, in response to a request for counsel about matters relating to loyalty made by The Assistant to the President, Sherman Adams, on 11 Jan. 1955 [*Science* 121, 7A (11 Feb. 1955)]. The report was dated 13 Mar. and released by the White House on 4 Apr. along with a letter of acceptance from Adams. Whether or not the report will lead to an Executive Order putting some or all of the recommendations into effect remains to be seen.

The members of the committee were Robert F. Bacher, professor of physics, California Institute of Technology; Laird Bell, attorney, Chicago, Ill.; Wallace O. Fenn, professor of physiology, University of Rochester; Robert F. Loeb, professor of medicine, Columbia University; E. Bright Wilson, Jr., professor of chemistry, Harvard University; Henry M. Wriston, former president of Brown University; and J. A. Stratton, *chairman*, vice president and provost, Massachusetts Institute of Technology.

and appointed the present Committee. . . . [Reference is made to appendixes A and B of the report, which contain the texts of Adam's request and Bronk's acknowledgment.]

The Committee has had the benefit of an extended discussion of policies and procedures with representatives of the principal Federal agencies concerned with the award of grants or contracts for unclassified research. . . . [Reference is made to appendix C of the report, which contains a more detailed account of the interviews.]

Setting of the Problem

The Committee confined its study to the question of alleged or confirmed disloyalty on the part of scientists, not employed by the Government, engaged in unclassified research under Government sponsorship in the private and State universities, hospitals, and laboratories of the country. It was not confronted, therefore, with the complex and difficult problems that surround the protection of "sensitive" projects and classified material.

Within the past several years the head of almost every Federal department and agency with a program of contracts or grants for unclassified research has been called upon to resolve in his own way the problem which is presented under the following circumstances:

When information reflecting on the loyalty of an individual who is employed on a Government-supported unclassified research project is brought to the attention of the head of the department or agency concerned and careful inquiry seems to indicate to his satisfaction that there is serious question of the individual's loyalty to the United States, what should be the course of action?

There appears to be no Act of Congress, including the appropriation Acts relating to awards for unclassified research, which provides guidance regarding the manner in which this question should be answered. Consequently, departments and agencies supporting unclassified research have pursued somewhat varying courses. This indicates that among responsible officials there is varying opinion as to what procedures should be applied in arriving at reasonable decisions. As a result there has been a growing concern on the part of the scientific community at large lest administrative practices that were developed for the handling of sensitive projects might gradually prevail over a larger domain and by slow diffusion from one department or agency to another ultimately affect the activities of all men and women engaged in scientific investigations under Government sponsorship.

The Role of Government in Unclassified Research

The part played by research in the advancement of science, and the contributions of science to the public welfare as well as to the national defense are now so widely understood that it seems hardly necessary to dwell upon the subject in the present report. Thus in a preamble to an Executive Order issued March 17, 1954, President Eisenhower stated that: ". . . the security and welfare of the United States depend increasingly upon the advancement of knowledge in the sciences; and . . . useful applications of science to defense, humanitarian and other purposes in the nation require a strong foundation in basic scientific knowledge and trained scientific manpower."

In a similar vein, the preface to a report on research and development in the Government presented to the Congress in May 1955 by the Hoover Commission contains the following statement: ". . . the foundation of the greatest sector of human advancement in modern times is basic research into nature's laws and materials. It is from these sources that come the raw materials of applied science. We owe to basic research the fabulous improvement in the health of the Nation; the greatest industrial productivity known to man; the weapons of defense which have protected our independence; and our knowledge of the laws which govern the Universe.

"There is no tribute great enough to express the Nation's obligations to its scientists, engineers, and military personnel, for their contributions to our constantly increasing productivity and the strengthening of our national defense. And there can be no relaxation in this effort."

The Government has now made clear that it has a vital concern in the promotion of unclassified scientific research, and that this concern extends to research at the most basic level. By this loose and often ambiguous word *basic* we designate research designed to elucidate the fundamental natural laws of the universe—to explore the innermost structure of the stars, to resolve the mystery of cosmic rays, to penetrate the atomic nucleus, to comprehend the forms and reactions that underlie chemical structure and biological phenomena, and to press forward the investigation of those complex molecules whose properties resemble life itself. Such research is the very foundation of efforts to develop materials and tools of our technological civilization, to improve communications among the peoples of the world, to master the genetics of corn, to produce food and shelter for an expanding population, to prevent or minimize heart disease, and to conquer cancer. If one believes in the beneficent uses of science for the welfare of our nation and of mankind, then one must also believe in the essential need for progress in basic research.

A fundamental contribution leading ultimately to the cure of cancer, providing it were made generally available, would be no less beneficial to all humanity for having been made by a communist. Authentic scientific progress carries with it no ideological flavor from its source. A major advancement in protein chemistry or a significant step in understanding the nature of growth must be judged on its intrinsic scientific merits; and it is of the utmost importance both to science and to humanity that such knowledge be widely and promptly disseminated in order that it may be reviewed, and subsequently confirmed, modified or extended by other scientists, the more readily to find application in the public interest.

Yet the idea persists that the Government in granting funds for research confers a favor upon scientists as individuals. We consider this contrary to the fact. In appropriating funds for the support of research, we believe the Congress to have been motivated by an urgent national need. The administration of these funds must be viewed in the perspective both of the intrinsic character of basic research and of its overriding importance in our age to the public welfare. The Committee believes that the Congress has acted wisely in making funds available to nongovernmental institutions free of encumbering regulations.

The responsibility of carrying out policies of the Government with respect to scientific research has been delegated to many agencies—among the foremost the National Institutes of Health, the National Science Foundation, the Atomic Energy Commission, the Department of Agriculture, and the Department of Defense. These agencies have drawn upon our material resources for the advancement of science in the private and State universities, hospitals and laboratories of the country. At an earlier period research in such institutions was maintained almost wholly from private endowment, State appropriations and grants-in-aid from charitable foundations. Private giving for the advancement of knowledge continues to play a crucial role in our society. But the magnitude of our present efforts and the cost of systematic attacks on the great unresolved problems of sicence are such that within the past decade it has become imperative to draw heavily upon public funds.

Through such grants and contracts the Government does not take upon itself the mantle of a charitable foundation on a grand scale, nor do scientists have any claim on public funds as the privilege of

a special class of citizens. The Government is engaged not in philanthropy, but in the procurement of the "raw materials of applied science" in the words of the Hoover Commission.

Protection of the Public Interest

In questioning the wisdom of some aspects of the loyalty program as applied to unclassified research conducted by persons not employed by the Federal Government, no member of this Committee condones disloyalty or suggests that the Government ignore evidence of the disloyalty of any citizen. We do believe that the proper objectives of Government in sponsoring basic research will be best served by concentration on scientific competence alone. The substance of unclassified research entails no secrecy and involves no danger to national security. Thus loyalty should have no special relevance to unclassified research, and there is no reason for singling out research for the application of loyalty requirements which set it apart from the multitude of other unclassified activities engaged in by the Government through contracts and grants.

The primary objective of a national research program is to serve the public interest by advancing knowledge in science as rapidly as possible. The only conceivable way by which a disloyal scientist doing unclassified research could sabotage this objective is by destruction of the scientific integrity of his own work. But the surest protection of the public interest against this kind of risk is the very process by which science protects itself from lack of objectivity. This process is the continuing scrutiny of the work of a scientist by his colleagues, in his own institution, his professional societies, the editorial boards of the journals in which he seeks to record his findings, and also in the reviewing bodies that examine both his past accomplishments and his proposed program if he is to be considered for a grant or contract. This critical scrutiny is well designed to assess the competence of the individual and to detect lack of scientific objectivity or integrity whatever may be the cause.

Nonetheless the Government should no more ignore criminal disloyalty in a scientist than in any other citizen. If there is evidence of criminal disloyalty or of any other crime under the law, it should be dealt with through the channels legally provided for the examination and disposition of such evidence—not through the administration of research grants.

Thus we maintain that serious allegations of disloyalty on the part of *any* individual indicating a violation of criminal statutes should continue to be promptly referred to the Department of Justice.

This is the positive action that every official of the Government or any other citizen can and should take when he comes into possession of evidence which in his opinion indicates the possible existence of disloyalty. It is our belief that in placing all such information in the hands of the Federal agencies of law enforcement established to deal with such matters he properly fulfills his responsibilities of office and of citizenship.

The Committee believes that when the maintenance of secrecy is contrary to the public interest, as is clearly the case with respect to unclassified research, irresponsible allegations reflecting upon the loyalty of individuals engaged in the program should be ignored. We are confident that formal confirmation of such a policy by the Federal Government would have a vastly reassuring effect upon the scientific community at large and would contribute much to the effective utilization of our national resources for the public interest through the advancement of science. On these grounds we think it sound public policy.

News of Science

Two Education Committees Established by the President

President Eisenhower announced on 28 Mar. the establishment of the President's Committee on Education Beyond the High School. Devereux Josephs, the chairman, is chairman of the board of directors of the New York Life Insurance Company, a member of the board of overseers of Harvard University, and a former president of the Carnegie Corporation of New York. The vice-chairman is David Dodds Henry, president of the University of Illinois.

The President indicated the need for this committee in his message to Congress on 12 Jan. when he said:

"Our vision would be limited if we failed at this time to give special thought to education beyond the high school. Certain problems exist now in this field, and already we can foresee other needs and problems shaping up in the future. Higher education is and must remain the responsibility of the States, localities, and private groups and institutions. But to lay before us all the problems of education beyond high school, and to encourage active and systematic attack on them, I shall appoint a distinguished group of educators and citizens to develop this year, through studies and conferences, proposals in this educational field. Through the leadership and counsel of this group, beneficial results can be expected to flow to education and to the Nation, in the years ahead."

In addition to studying the problems of providing good teaching and housing for the expected major increase in college enrollment during the next 10 years, the committee will consider possible recommendations for steps to meet the shortage of scientists and engineers. It will also be concerned with the waste of talent because students fail to continue their education in high school or college until they develop their fullest capacities.

* * *

The establishment of another committee, the National Committee for the Development of Scientists and Engineers, was announced by the President on 3 Apr. This committee was named at the recommendation of a special interdepartmental Government study group that was headed by Arthur S. Flemming, director of the Office of Defense Mobilization.

In his announcement the President commented that the study group had recognized "that although the Government has a responsibility for increasing the supply and improving the quality of our technological personnel, the basic responsibility for solution of the problem lies in the concerted action of citizens

and citizens' groups organized to act effectively."

Paul Sears, president of the AAAS, and Detlev W. Bronk, president of the National Academy of Sciences, are two of the 17 representatives of education, the professions, foundations, industry, and labor that make up the new committee. Howard L. Bevis, president of Ohio State University, is chairman of the committee, and Eric A. Walker, dean of the College of Engineering and Architecture at Pennsylvania State University, is vice-chairman.

In a letter to Bevis, the President said he hoped the new committee would:

"1) Assist the Federal Government in identifying the problems associated with the development of more highly qualified scientists and engineers.

"2) Enlist the cooperation of all interested individuals and groups in analyzing the problem and developing programs to deal with it, and to take the lead in coordination of interested organizations outside the Federal Government.

"3) Make available to all interested organizations information on effective ways of overcoming the obstacles to the training of more qualified scientists and engineers.

"4) Publicize the problem and possible solutions in order to stimulate widespread public understanding and support.

"5) Provide the President, from time to time, with a report of progress."

Transmission-Type Photomultiplier

A new-type photomultiplier tube, which obtains its electron multiplication by the use of thin, plane-parallel, nonmetallic films instead of conventional metal dynodes, has been developed by E. J. Sternglass and M. M. Wachtel of the Westinghouse Research Laboratories. The tube is finding particular application in high-speed pulse counting. Preliminary measurements indicate it should be capable of timing atomic events, such as the time of flight of a proton or neutron over a fixed distance, down to 10^{-10} second—a fiftyfold gain in speed over conventional photomultipliers.

In a conventional tube, the secondary electrons—which give photomultipliers their amplifying effect—are obtained from thick metal plates. An electron, striking the front surface of the plate, ejects several secondary electrons from that surface. These electrons must be directed through complicated paths of varying lengths to additional stages composed of such plates. Because of this, the electrons tend to "straggle" through the tube as they progress from stage to stage and do not give as sharp an amplified electron pulse at the output of the tube as is required for studying physical phenomena that take place in less than one-hundredth of a microsecond.

In contrast, the new photomultiplier obtains its secondary electrons from the rear surfaces of thin films composed of alkaline earth oxides or alkali halides. The tube has a straight-through construction, with the films placed parallel to one another. The secondary electrons, therefore, always move straight ahead as they are accelerated from stage to stage. This shortens their transit time through the tube, minimizes electron "straggling," and produces a sharp output pulse with exceedingly short rise time.

By using nonmetallic films, such as KCl, the new photomultiplier also takes advantage of the fact that such materials have a secondary electron yield many times larger than those from any known metal.

The nonmetallic films used in the transmission photomultiplier are about two-millionths of an inch in thickness. The films are evaporated in a vacuum onto a film of SiO that is five times thinner, which helps give strength to the KCl. Between these two films is deposited a third film of gold that is only a few atomic layers thick. The whole three-layer "sandwich" is supported on an electroformed metal screen of 100–200 holes per linear inch and 50 percent open area.

Measurement of the pulse amplifying characteristics have been carried out with a transmission photomultiplier of seven stages. The total transit time of the electron pulse through the tube was found to be only 3×10^{-9} second. The agreement of measured and calculated values for the transit time indicates no intrinsic delay in secondary emission beyond 10^{-10} second. Thus, an extension of time interval measurements down to this figure appears feasible.

News Briefs

■ A subcommittee of the National Committee on Radiation Protection has been appointed to deal with problems of protection against high-intensity electron radiation produced by accelerators. Members will solicit data and prepare recommendations for installations where radiation-producing machines, such as betatrons, Van de Graaf generators, and linear accelerators, are used. This activity will be an extension of the earlier work of the NCRP in related fields.

Lester Skaggs, Argonne Cancer Research Hospital, Chicago, is chairman. The members are E. A. Burrill, High Voltage Engineering Corporation, Cambridge, Mass.; H. W. Koch, Betatron Laboratory, National Bureau of Standards, Washington, D.C.; J. S. Laughlin, Memorial Hospital, New York; R. F. Post, Radiation Laboratory, University of California, Livermore; and E. D. Trout, X-ray Department, General Electric Company, Milwaukee, Wis.

■ By changing its tools—a matter that requires a few hours—a new automatic assembly machine, the Multra Machine, designed and built by the Multra Corporation, a subsidiary of Barnes Engineering Company, can be used to assemble a variety of products. Usually, assembly machines are built to do specific jobs.

An example of true automation, Multra has a feedback system. The machine feeds, sorts, sizes, forms, orients and inspects the parts to be assembled. If a part should fail to be inserted into a subassembly, then no further parts are fed into that subassembly and it is rejected at a late station.

A Multra machine is now in use assembling mercury batteries for P.R. Mallory and Company. The machine performs all of the battery assembly operations that formerly required a human operator, turning out between 15,000 and 20,000 batteries per 8-hour shift.

■ The use of an experimental heart-lung machine to reduce the risk of at least one serious heart operation has been reported by a group of Rochester, Minn., researchers. The machine shunts the blood past the heart and lungs, supplying it with oxygen before returning it to the body.

The physicians used the machine during surgery on 20 patients who had congenital defects in the wall of one heart chamber, complicated by high blood pressure in the lungs. Sixteen of the patients, including 15 children under 12 years and one 29-year-old man, survived and showed pronounced improvement. Four children died of pulmonary complications.

According to the group making the report, the results of the operations show that the surgical risk to the patient is "acceptably low, considering the severity of the condition." The risk depends on the age, general health, and the presence or absence of cardiac failure and pulmonary complications.

Mayo Clinic and Mayo Foundation staff members who made the report are James W. DuShane, John W. Kirklin, Robert T. Patrick, David E. Donald, Howard R. Terry, Jr., Howard B. Burchell, and Earl H. Wood.

■ The latest financial report of the Atomic Energy Commission states that appropriations for fiscal years 1940 through 1955 amounted to $14.4 billion. Assets amount to $9.1 billion as of 30 June. These figures are not complete, however, because for security reasons inventories of stockpiles are not included.

■ The generating station at the Shawinigan Water and Power Company's new hydroelectric development at Rapide Sans Nom, Quebec, will be of the most modern outdoor type, without superstructure. Construction will start this spring on the St. Maurice River.

The plant will operate under a head of 125 feet and is designed for six generating units with a total capacity of 248,000 kilowatts, or 330,000 horsepower. Rapide Sans Nom is about 10 miles upstream from La Tuque.

Since the new dam will raise the river level some 110 feet, a 9-mile diversion of the Canadian National Railways transcontinental main line will be necessary.

■ A petrified tree stump with an estimated age of 80 million years has been excavated by workmen on the site of the Army's Nuclear Power Package Reactor at the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va.

A left-over of the Cretaceous age, the stump could be as much as 130 million years old, according to Roland Brown, a U.S. Geological Survey paleobotanist who identified it at the Smithsonian Institution. The stump predates the Ice Age by many millions of years. A cypress-type tree that was found in the "Potomac group," a sedimentary formation of river sand and clay with minor gravel lenses, it measures 4 feet by 18 inches.

■ Of the $164 million spent in 1953 by the 77 large privately endowed foundations, $26 million was spent for scientific research. These figures are drawn from a recent survey made by the Russell Sage Foundation for the National Science Foundation. The private foundation expenditures for science are less than 1 percent of the estimated national total for all research and development. Forty three of the 77 major foundations supported scientific research.

■ In agreement with the United Kingdom and the Commonwealth of Australia, Canada is to participate in the series of atomic trials to be held in Australia in late 1956. Members of the Canadian forces and the Defense Research Board will assist in the trials, and items of Canadian service equipment will be exposed to the effects of the nuclear weapons.

■ The U.S. Atomic Energy Commission has removed a suspension order on gem irradiations that has been in effect since 1953. The commission will now treat requests for irradiation of gems in the same manner as requests for irradiation of other materials.

As is well known, irradiation may change the color of gems. Radiations from a particle accelerator may produce blue or blue-green colors in diamonds. Irradiation in a nuclear reactor may produce a green color, which may turn brown under certain conditions of heating. Although diamonds irradiated in a nuclear reactor become radioactive, this activity decays in a few days to an insignificant level.

■ The Republic of the Philippines has been chosen as the site for the new Asian Nuclear Center. The choice was made public by the State Department on 15 Mar. This center was proposed by the United States at the Colombo Plan meeting that was held in Singapore last October. The State Department's announcement concluded:

"The United States is now preparing to move rapidly with initial plans for the establishment of this center as a means of putting atomic energy to work for the economic and social progress of Asia. This action will represent an important step toward the further advancement of President Eisenhower's atoms-for-peace program."

Scientists in the News

The National Academy of Sciences will make the following awards at its annual meeting in Washington, D.C., 23–25 Apr.

ALFRED C. REDFIELD, associate director of the Woods Hole Oceanographic Institution and professor of physiology at Harvard University, received the Agassiz medal for his contributions to oceanography.

ARCHIE CARR, professor of biological sciences at the University of Florida, received the Daniel Giraud Elliot medal in recognition of his work, *Handbook of Turtles*, an account of all of the kinds of turtles found in the area north of Mexico, but including Lower California.

SEWALL WRIGHT, professor of genetics at the University of Wisconsin, received the Kimber medal for his contributions in both theoretical and experimental genetics.

ALEXANDER ROMER, Alexander Agassiz professor of zoology and director of the Museum of Comparative Zoology at Harvard University, received the Mary Clark Thompson medal, which is awarded for distinguished services to geology or paleontology.

CHESTER B. WATTS, director of the 6-inch transit circle division of the Naval Observatory, received the James Craig Watson medal for his contributions to astronomical research.

H. C. VAN DE HULST, professor of theoretical astronomy at the University of Leiden, has received, in absentia, the Draper medal for his contributions to radio astronomy.

SAM L. CLARK, head of the department of anatomy at Vanderbilt University School of Medicine, delivered the annual Robert J. Terry lecture on 21 Mar. at the Washington University School of Medicine (St. Louis). The lectureship, established in 1938, honors Terry, professor emeritus of anatomy who was head of the department of anatomy from 1900 until his retirement from teaching in 1941. He still is active in research.

LLOYD McCLAIN PARKS has been appointed dean of the College of Pharmacy at Ohio State University. He was formerly professor of pharmaceutical chemistry at the University of Wisconsin.

Two physicians were presented with Ross awards of $1000 each by the Academy of General Practice during its recent national convention. The awards are given annually for the most important contributions to scientific literature by physicians in general practice.

The recipients were CECILE L. FUSFELD of Washington, D.C., for a paper on detection of cancer of the reproductive tract during routine examination of women who had no clinical signs of the disease; and EDWARD SETTEL of Forest Hills, N.Y., for reporting on the use of chlorpromazine for tranquilizing disturbed senile patients.

CLIFFORD BECK, head of the department of physics at North Carolina State College, will take a year's leave of absence in June to become scientific adviser to the director of the Atomic Energy Commission's Division of Civilian Application.

A.C.S. VAN HEEL of the Technical University, Delft, Netherlands, is giving a series of lectures on polarized light at the National Research Council of Canada, where he will work several months on such problems as (i) measuring the optical path differences in microscopic and macroscopic objects and (ii) precision alignment and its technical applications to the setting up of machinery.

EGER V. MURPHREE, president of the Esso Research and Engineering Company, has been appointed to the newly created position of Special Assistant to the Secretary of Defense for Guided Missiles.

PAUL R. BURKHOLDER, head of the department of bacteriology at the University of Georgia, has been appointed director of research at the Brooklyn Botanic Garden, effective 1 July.

CLINTON R. HANNA, associate director of the Westinghouse Research Laboratories in Pittsburgh, Pa., has received the Benjamin Garver Lamme medal of the American Institute of Electrical Engineers. He was honored "for his fundamental calculations and developments in the field of electrodynamics, and particularly for his achievements in the design of voltage regulators, automatic rolling mill controls, and tank gun stabilizers."

J. J. RAIMOND, JR., director of the Zeiss Planetarium at The Hague, Netherlands, lectured at Georgetown University on 2 and 9 Apr.

H. L. SHEEHAN, professor of pathology at the University of Liverpool, Liverpool, England, delivered a lecture on "A typical hypopituitarism" at the Yale–New Haven Medical Center on 9 Apr.

PHILIPP G. FRANK, physicist, philosopher, and retired lecturer on physics and mathematics at Harvard University, has joined the faculty of the Massachusetts Institute of Technology for the current term as visiting professor in the School of Humanities and Social Studies. He will teach a guest course on the acceptance of scientific theories.

HARRIS WALDO BIRD, JR., has been appointed associate professor of psychiatry in the Medical School of the University of Michigan. Bird was formerly associate professor of psychiatry in the University of Chicago Medical School.

FRANK H. BABERS, former biochemist with the Entomology Research Branch, U.S. Department of Agriculture, Beltsville, Md., is now acting head of the Biology and Chemicals Branch at the Quartermaster Research and Development Center, Natick, Mass.

PAUL E. WAGGONER has been named head of a new department of climatology at the Connecticut Agricultural Experiment Station, New Haven. He was previously a member of the station's department of plant pathology and botany, in which his research was concerned both with microclimatology as it relates to the spread of plant diseases and with the effect of atomic radiation on plant diseases.

ROBERT O. SAUER has been appointed vice president in charge of research and development at Velsicol Chemical Corporation, Chicago, Ill. Sauer was formerly engaged in development engineering work for the General Electric Company at Waterford, N.Y.

CHRIS A. HANSEN, an assistant chief of the Public Health Service's Communicable Disease Center in Atlanta, Ga., and an employee of the center since its organization in 1946, was appointed head of the Division of Research Services at the National Institutes of Health, Bethesda, Md., on 1 Apr.

ROBERT C. MYER has been appointed executive director of a special 3-year project on the mentally retarded, with headquarters in the Columbus State School, Columbus, Ohio. Myers was formerly chief of community mental health services for the New Jersey State Department of Institutions and Agencies in Trenton. The project is being developed under a $230,000 grant from the National Institute of Mental Health.

JOHN B. BARNWELL has been appointed assistant chief medical director for research and education in the department of medicine and surgery of the Veterans Administration at Washington, D.C. Barnwell succeeds George M. Lyon, whose appointment as manager of the Veterans Administration Hospital at Huntington, W. Va., previously was announced.

LLOYD C. FERGUSON, professor of veterinary science at the Ohio Agricultural Experiment Station at Wooster, has been appointed head of the department of microbiology and public health at Michigan State University, effective 1 July. Other appointments at Michigan are: AUBREY E. WYLIE, of the State University of New York, who will become professor of forest products, effective 16 Aug., and ALLEN K. PHILBRICK of the University of Chicago, who will assume the post of associate professor of geography, effective 1 Sept.

HEINZ G. F. WILSDORF, principal research officer of the National Physical Laboratory, Council for Scientific and Industrial Research, Pretoria, Transvaal, Africa, will join the staff of the Franklin Institute early in the summer as senior research metallurgist in the solid-state physics division.

CARROLL L. BIRCH, professor of medicine at the University of Illinois, received the Elizabeth Blackwell medical citation on 22 Jan. in New York. She was honored at the New York Infirmary in "recognition of her distinguished achievement in the study and teaching of tropical medicine."

The award is presented in memory of Elizabeth Blackwell, the first woman to receive a formal medical education in modern times. Dr. Blackwell was graduated in medicine in 1849 and was the founder of the New York Infirmary.

Education

■ As a result of a grant from the Rockefeller Foundation, the Centre International d'Epistemologie Genetique was recently established in the Faculty of Science of the University of Geneva, Geneva, Switzerland, under the direction of Jean Piaget. The center, which is interdisciplinary, is closely associated with the department of psychology. It consists of a team of research workers from the logico-mathematical, natural, and psychological sciences interested in the experimental and theoretical study of developmental behavior.

The general topic of study for the present year is the relationship between logical structures and the behavior and thought of a subject in his development. A guest symposium on this topic will be held in July 1956, when the center's first publication will also be released. Inquiries and correspondence should be addressed to the acting secretary, Mlle. S. Taponier, Centre International d'Epistemologie Genetique, Geneva 14, Switzerland.

■ A Computation Center will be opened on 1 Sept. at the Carnegie Institute of Technology under the direction of Alan J. Perlis, at present head of the computing laboratory at Purdue University. In addition to supplying computing service to the institute, industry, and the Government, the center will be used as a research tool for developing the theory of machine computation. The new center is made possible by the IBM educational contribution program.

■ An educational experiment at Rensselaer Polytechnic Institute has indicated that colleges of science and engineering could successfully advance some students to graduate studies without benefit of the senior year.

This finding was the result of a 6-week experimental program conducted at the institute last summer.

Ten students, who had just completed their junior year and who had been carefully screened for promise of achievement, were selected from ten colleges and universities to participate in the experiment. Their previous experience had been in the fields of physics, chemistry and metallurgical engineering.

The two courses that were given dealt with the chemistry and physics of metals.

The program will be repeated next summer. Each participant will be given a full-tuition scholarship and travel and living expenses as well. College juniors who feel qualified should address inquiries to Dr. Arthur A. Burr, Department of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N.Y.

■ A 3-year research and training program in water resources development, supported by a grant of $150,000 from the Rockefeller Foundation, will be in full operation next September at the Harvard Graduate School of Public Administration.

The purpose of the program is twofold: to study the water resources problems of today from the viewpoints of the engineer, the economist, and the political scientist; and to train each year 10 government officials from agencies that are concerned with conservation and related problems. The fellows will be awarded the degree of Master of Public Administration.

Arthur A. Maass, who will lead a weekly seminar, gives this description of the program and the problems that gave rise to it:

"Rising population, booming industrial and economic activity, growing cities—all impose new and heavy demands on our water resources. The economic and social consequences of such old problems as floods and drought have become intensified. New problems, such as pollution by industrial wastes, have arisen.

"There have been many important studies of water resources policy and administration, but the problems have not been eliminated. Serious inconsistencies of approach have obscured the basic problems. They have worked against the development of a unified planning process through which various agencies could integrate plans for a specific area.

"In the university, without constant tensions and pressures for action, we can work toward such an approach. We can also fill a particular need in water resources planning and development today—the need for fundamental research bringing together the knowledge and research of both the social and the applied scientist."

■ A gift of $2 million by Frank Jay Gould will help complete the engineering and science center at the University Heights campus of New York University.

The sum will cover half the cost of a new building that is to contain education and research facilities for physics; chemical, electrical, mechanical, and industrial engineering; meteorology and oceanography; and a science and engineering library.

■ Cornell University will offer a course in techniques and applications of the electron microscope from 11 to 23 June. Further information may be obtained from Prof. Bernard M. Siegel, Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, N.Y.

■ Occupation of the new administration and laboratory building of the University of California's Los Alamos Scientific Laboratory began late in January. When the entire transfer is completed, the 560 offices in the building will be occupied by nearly 1000 members of the laboratory staff.

The new structure is situated in the laboratory's technical area across Los Alamos Canyon on South Mesa. Here also are located the new physics building, chemistry and metallurgy building, shops building, and other new facilities. Except for a few of the old, temporary, wartime structures still remaining on Los Alamos Mesa, the laboratory has approached the completion of its 5-year program of shifting its facilities and personnel to the technical area so that it will be completely divorced from the community of Los Alamos.

■ A graduate educational program in the biological sciences basic to medicine will open in September at the State University of New York's Medical Center in Brooklyn. The new curriculum, which will admit candidates for the Ph.D. degree, initially will offer programs in anatomy, biochemistry, pharmacology, and physiology. Requests for information and applications should be addressed to State University of New York College of Medicine, 462 Clarkson Ave., Brooklyn.

Grants, Fellowships, and Awards

■ The American Chemical Society has established the James T. Grady award to honor the person who makes "an important presentation through an appropriate medium of public communication for increasing the knowledge and understanding by the American public of chemical progress [*Science* **122**, 117 (1955)]. Fields that may be included are press, radio, television, films, the lecture platform, books, pamphlets, or any other field deemed pertinent."

This award will first be made in 1957, and the *closing date for nomination is 1 June*. The award consists of a gold medal, a certificate, and an allowance of $150 to travel to the ACS meeting where the award is presented.

Bob Potter, Chemical Society of the County of New York, 2 E. 103 St., New York 29, N.Y., has been appointed chairman of the Canvassing Committee for this award. Each nomination must be submitted by a member of the ACS.

■ Climax Molybdenum Company will sponsor grants-in-aid at 15 universities and two independent research foundations for agricultural and biological research on molybdenum during 1956–57. These grants totaled $36,000. This is an increase over the 17 grants, totaling $26,500, that were made last year.

This program of sponsored agricultural research was inaugurated in 1950 when the problem of molybdenum-deficient soils in this country first became apparent. At that time, it was known that molybdenum was essential to plant growth, and that commercial use of molybdenum to promote crop yield was widespread in Australia and New Zealand. But the existence of extensive molybdenum-deficient soils in the United States was unsuspected, and treatment of different crops with molybdenum chemicals had rarely been tried here.

About 35 molybdenum-deficient areas have been located in some 20 states, and new ones are being reported regularly. Some dozen crops are being treated commercially with molybdenum chemicals in various sections of the country. Research findings have established the need for molybdenum in nitrogen fixation in legumes and in the enzyme systems that control protein synthesis by plants.

■ The University of Georgia Ecological Studies directed by Eugene P. Odum at the Savannah River Plant of the U.S. Atomic Energy Commission are entering a second phase of development. Following several years of rather broad studies of the basic environment and major populations on the 200,000-acre plant reservation, specific experimental research is planned to help provide a sound basis for solving the ecological problems of radioactive waste disposal. Research assistantships are available for Ph.D. candidates who desire training in radiation ecology, a new field that is expected to become important in the future. Address inquiries to Dr. E. P. Odum, Department of Zoology, University of Georgia, Athens.

■ Eleven grants totaling $491,328 from the U.S. Public Health Service, will enable hospitals, health agencies, and community groups to conduct research and demonstrations for the improvement of hospital services. The funds were made available by the Congress under the Hospital Survey and Construction Act. The awards, approved by the Federal Hospital Council at a meeting on 1 March, go to the following:

Beth Israel Hospital, Boston, Mass., to develop methods of evaluating a hospital's outpatient service.

Connecticut Hospital Association, New Haven, to demonstrate the value of supplying member hospitals with the continuous service of consultants in the fields of personnel and dietary administration.

Catholic Hospital Association of the United States and Canada, St. Louis,

Mo., to develop a nontechnical manual of specific guides to help hospital administrators use accounting techniques in planning and controlling various phases of hospital operations.

American Hospital Association, Chicago, for a study of medical records systems to find out which system of coding and indexing provides the greatest number of useful records most easily and economically.

Hospital Council of Philadelphia, for a study to determine to what extent hospitals are making private offices available to doctors and the advantages and disadvantages of these arrangements.

United Hospital Fund of New York, for an analytic study of management improvement programs in hospitals and a demonstration to show how hospital organizations can help hospitals start these programs and carry them on effectively.

Georgia Department of Public Health, Atlanta, for an educational demonstration in small hospitals to train dietary supervisors who are not graduate dieticians.

Community Studies, Inc., Kansas City, Mo., for a master plan for the coordination of a base hospital center with the health and medical resources in the entire area served by the base hospital.

United Community Services of Metropolitan Boston, for a demonstration to show how the hospital and health services of a single city and its suburbs can be coordinated and a program developed to increase the quality and availability of medical care.

University of Texas, Austin, for a comparative study of two types of communities and their hospital services, to find the relationship between the social organization of a community and the success of its general hospital.

American Association of Medical Record Librarians, Chicago, to develop standards and procedures for keeping and using medical records in chronic disease hospitals.

In the Laboratories

■ Organization of a firm for general consultation on all aspects of air pollution has been announced by Wesley C. L. Hemeon, presently engineering director of the Industrial Hygiene Foundation and senior fellow of the Mellon Institute. Hemeon will be director of the new firm, which is to be known as Hemeon Associates. Headquarters offices and laboratory will be in the Leoffler Building at 121 Meyran Avenue, Pittsburgh, Pa.

Heading a staff of specialists in various aspects of air pollution will be George F. Haines, Jr. The staff will be supplemented by a team of consulting associates that will completely embrace the several fields of chemistry, engineering, meteorology, plant physiology and pathology, and wind tunnel aerodynamics.

■ The U.S. Atomic Energy Commission has announced that it will add ordnance engineering to its weapons development activities in Livermore, Calif. The new function will be carried out by the Sandia Corporation, Albuquerque, N.M.

Sandia plans to increase its staff in Livermore to about 250 by July 1957, and to 800 to 1000 by July 1958. Most of those added will be engineers and draftsmen.

■ Formation of a nucleonics research section in the research department of Stromberg-Carlson, a division of the General Dynamics Corporation, has been announced. The section will be headed by Robert L. Deming, who joined Stromberg-Carlson recently after having served for more than 4 years as a research staff member at the Los Alamos Scientific Laboratory, Los Alamos, N.M. Matthew P. Tubinis and Thomas T. Thwaites, both physicists, will assist Deming.

■ A research section for metallurgical problems in the atomic energy field, the reactor metallurgy section, has been established at Armour Research Foundation of Illinois Institute of Technology. Donald J. McPherson, assistant manager of the metals research department, will be acting supervisor of the section, and Ray J. Van Thyne has been named assistant supervisor.

■ The Radio Corporation of America has announced plans for the establishment of an Advanced Development Laboratory in the New England Industrial Center at Needham, Mass. A one-story brick building, comprising 20,000 square feet, has been leased and will be occupied this month.

The new plant will be utilized for advanced developmental work on ferrites under the direction of Francis E. Vinal. Ferrites are inorganic chemical compounds formed from metallic oxides and are widely used in components for television receivers, computers, and in high-frequency applications.

■ A new technique for manufacturing transistors has been announced by Texas Instruments, Inc., Dallas. The new "grown-diffused" technique works with both germanium and silicon. The resulting commercially available kernel-sized production transistors amplify electric signals at usable power levels to frequencies of more than 100 megacycles per second and will oscillate at frequencies of more than 250 megacycles per second.

Miscellaneous

■ The United States Civil Service Commission has announced an examination for filling geophysicist positions in the Coast and Geodetic Survey of the Department of Commerce, in other Federal agencies in Washington, D.C, and throughout the United States. A few positions may also be filled overseas. The salaries range from $4345 to $11,610 a year.

For positions paying from $4345 to $5440 a year, education alone may be qualifying. No written test is required.

Further information and application forms may be obtained at many post offices throughout the country, or from the U. S. Civil Service Commission, Washington 25, D.C. Applications will be accepted by the Board of U.S. Civil Service Examiners, Coast and Geodetic Survey, Department of Commerce, Washington 25, D.C., until further notice.

■ The British Information Services have announced the availability of a 17-minute film that illustrates the development of the rocket from a Chinese firecracker, through various 17 century inspirations for space travel, to its applications of today. The film shows activities at three rocket research establishments in Britain that have never before been shown to the public.

Pictures of rocket-firing aircraft straffing enemy shipping and supplies, and of the V-2 weapon at Peenemunde, the secret German rocket base, emphasize the part played by rockets in World War II. Some photographs of the American coastline and the Gulf of Mexico taken from a V-2 90 miles up are included.

The film also shows some American post-war experiments in rocket development and discusses the future that may lie ahead in this important field. The two 16mm black and white reels may be rented for $3.50 from the British Information Services, 30 Rockefeller Plaza, New York 20.

■ A collection of 230,000 specimens of termites, including 1286 species of the approximately 2000 known in the world, has been presented to the Smithsonian Institution by the U.S. Department of Agriculture Forest Insect Research. Thomas E. Snyder, retired USDA entomologist, has been making the collection for 46 years.

Among the specimens are 943 type specimens—that is, individuals to which all others of the species must be referred for final identification. When Snyder started his collection in 1915 there were only 12 identified species of termites in the Smithsonian collections.

Reports and Letters

Exposure Duration as a Variable in Perceptual Constancy

The perception of the size, shape, brightness, and color of objects may be considered a compromise between the constant physical characteristics and the continually varying retinal image properties of the objects. The usual tendency to emphasize the constant properties of objects is known as perceptual constancy. A major problem in the study of these phenomena is the explanation of the mechanism by which this perceptual stability is mediated. To gain some insight into the nature of this process, experiments were performed to determine the effect of reduced exposure duration on the perception of shape, size, and brightness (*1*).

In the first study (*2*), matches were made between a circular object that was rotated at various angles to the subjects' line of vision and a series of ellipses. The results obtained at a 1.0-sec exposure duration were typical of data obtained in constancy studies in that the matched ellipses were rounder than would be predicted from geometric optics, tending in varying degrees to approach the circularity of the object. With a decrease in exposure duration to 0.01 sec, this tendency toward constancy was destroyed, and the resulting matches were in good agreement with retinal image theory. Thus, in the perception of shape, reduced exposure duration eliminates the tendency toward perceptual constancy.

In order to determine the generality of this finding with respect to the perception of size and brightness, two additional experiments were performed in both of which a major variable was a comparison of data obtained at a long and at a short exposure duration. To determine the effect of reduced exposure duration on the perception of size, we had the subjects view one of a series of circular disks presented at distances from 12 to 192 ft and adjusted in size so that, regardless of distance, the visual angle subtended at the eye was constant at 1.07 deg of arc. A spot of light 65 ft distant in a dark corridor was matched to equal these disks in size for both continuous illumination of the disks and, for a different group of subjects, while viewed by the 0.0005-sec flash from a "strobotron" lamp.

The data are plotted in Fig. 1. On this graph, the horizontal line represents a prediction in terms of geometric optics.

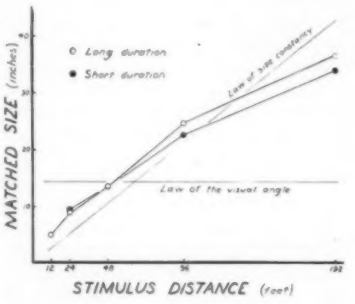

Fig. 1. Matched size as a function of distance at a long and a short duration of exposure for stimuli subtending the same visual angle.

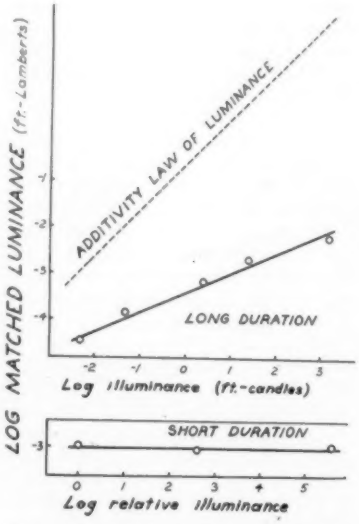

Fig. 2. Matched luminance as a function of field illuminance for a gray paper on a white background at a long and a short exposure duration.

The line labeled "law of size constancy" represents prediction in terms of constancy. The data for the long duration are in agreement with the results of previous investigators, especially those of Holway and Boring (*3*), after which this experimental arrangement was modeled. Perceptual constancy is good up to 96 ft, but it falls off slightly at longer distances. The data for the short duration are essentially identical with those obtained under continuous illumination, demonstrating that reduced exposure time has little effect on the perception of size.

In the third study on the perception of brightness, a square piece of gray paper mounted on a white background was viewed over an ambient illumination range of more than 100,000 to 1 and matched with a photometric field (*4*). The data obtained for continuous illumination and with a strobe lamp that provided flashes of 0.0005-sec duration are plotted in Fig. 2. On this graph, a line of unit slope represents an expectation based on energy relationships, and a line of zero slope represents a prediction in terms of brightness constancy. It can be seen that the effect of reducing the exposure time is to reduce the slope of this function so that it is brought more nearly in line with the law of brightness constancy.

Thus it can be seen how reduction of exposure duration differentially affects the tendencies toward shape, size, and brightness constancy. Shape constancy is reduced, size constancy is unaffected, and brightness constancy is improved. A possible interpretation from the results of previous experiments is that perceptual constancies depend on the presence in the visual field of stimuli in addition to the discriminative stimulus (*5*). If the same experimental procedure—for example, reduction of exposure time—affects the three types of measures differently, it follows that the additional stimuli and the process of interaction between these additional stimuli and the discriminative stimulus must, to some extent, be different, depending on the visual measure under consideration.

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17 October 1955

Studies on Tryptophan and Serotonin in Patients with Malignant Carcinoid

This is a report of an abnormality of tryptophan metabolism in patients with metastatic malignant carcinoid, a relatively rare disease that Thorson *et al.* showed to be associated with an unusual syndrome consisting of intestinal hypermotility, bronchospasm, vasomotor disturbances, and cardiac lesions (*1*). The demonstration of the presence of the pharmacologically active agent, serotonin (5-hydroxytryptamine), in carcinoid tumors (*2*) implicated it in the pathogenesis of this disorder. Since Thorson's report many additional patients with this disease have been reported.

A preliminary report from this laboratory indicated that the urinary excretion of 5-hydroxyindoleacetic acid (5HIAA), the major metabolite of serotonin, was greatly increased in patients with malignant carcinoid (*3*). Since previous animal studies had shown tryptophan to be the dietary precursor of serotonin (*4*), an investigation of tryptophan metabolism was undertaken in patients with this disorder (*5*).

Blood levels of serotonin were found to range from 0.6 to 3.0 μg/ml in carcinoid patients as compared with 0.1 to 0.3 μg/ml in normals. A tremendously elevated excretion of urinary 5HIAA, 70 to 800 mg/day in carcinoid patients as compared with 2 to 9 mg/day in controls, was found to be diagnostic of this condition (*3*).

The excretion of labeled 5HIAA following the administration of 2-C^{14} DL-tryptophan to three of the patients demonstrated that in human beings tryptophan is the precursor of serotonin and its metabolites. A quantitative estimate of the defect in tryptophan metabolism in this disorder was shown in the following experiment. One patient was fed a diet that gave a basic daily intake of 500 mg of tryptophan, and at various intervals the tryptophan intake was increased. The daily excretion of total 5-hydroxyindoles and of 5HIAA was measured and nitrogen balance was determined, as shown in Fig. 1. The urinary excretion of 5-hydroxyindoles increased when the tryptophan intake was increased and returned to control levels when the original intake was resumed. At a daily intake of 500 mg, as much as 60 percent of the dietary trytophan was converted to 5-hydroxyindoles. In normals only about 1 percent is metabolized in this way. The normal requirement of tryptophan has been estimated by Rose to be 150 to 200 mg/day (*6*). If this is correct, then this patient was just maintained in nitrogen balance at an intake of 500 mg.

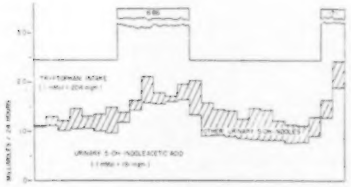

Fig. 1. The effect of variations in tryptophan intake on nitrogen balance and urinary excretion of 5-hydroxyindole compounds.

It is apparent that the carcinoid tumor is parasitic upon the tryptophan stores of the patient and, as a result, less of this amino acid may be available for formation of other metabolites, such as protein and niacin. Weight loss and hypoproteinemia are common features of the condition, and pellagra has been reported in several cases. The complex manifestations of this disorder may be related to both a serotonin excess and a tryptophan deficiency.

The conversion of what is normally a minor pathway of tryptophan metabolism into a predominant route of metabolism may make patients with malignant carcinoid useful in further studies on the biochemistry and physiology of serotonin.

Details of these studies will be published elsewhere (*7*).

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19 October 1955

Elastase Production in the Canine Pancreas

In 1950 Balo and Banga (*1*) reported the action of an extract of beef pancreas on pure elastin. The active substance, in view of its specificity, was termed "elastase." This work has been confirmed many times, and in addition these authors have reported that in human atherosclerosis the quantity of elastase extractable from the pancreas diminishes (*2*). Pepler and Brandt (*3*) demonstrated the action of elastase on the ground substance of aorta; the possibility of this enzyme's playing a part in the development of atherosclerosis has been noted further recently (*4*).

The following observations have been made concerning the production of elastase in dog pancreas. Pancreatic function in healthy mongrel dogs was modified by the following procedures.

1) Alloxan destruction of beta cells in the pancreatic islets. Two doses of alloxan (75 mg/kg. body weight) were given intravenously at 24-hour intervals. The animals were sacrificed 24 hours after the last dose. The loss of granules in the beta cells was demonstrated histologically.

2) Destruction of both alpha and beta cells in the pancreatic islets. Two doses of alloxan were given as before; following the last dose, 300 mg of cobalt chloride in 25 ml of water were given intravenously at hourly intervals for three doses. The animals were sacrificed 1 hour after the last dose. Complete lysis of both alpha and beta cells was demonstrated histologically.

3) Destruction of the pancreatic acinar tissue. Progressive destruction by fibrosis was produced by gradual occlusion of the pancreatic duct by a magnesium band placed about the duct. The technique, described elsewhere (*5*), provides both fibrosed and normal pancreatic tissue for assay in the same animal.

Elastase assays of residual pancreatic tissue were made by the method of Hall and Gardiner (*6*), over an incubation time of 18 to 20 hours, after preparation of the extracts by the method of Balo and Banga (*1*).

The elastolytic activity of pancreatic extracts varies a little with the elastin preparation and the results shown here in group 1 and groups 2a and 2b represent experiments carried out on three separate preparations of elastin.

Group 1a (control). Thirty-one assays of normal pancreatic tissue had an average elastolytic activity of 0.51 mg of elastin per hour (S.D. = 0.12).

Group 1b (experiment). Sixteen assays of pancreatic tissue modified by the administration of alloxan (method 1) showed an average elastolytic activity of 0.31 mg per hour (S.D. = 0.112).

The standard error of the difference between the two groups is 0.12, and it is considered that destruction of the beta cells in the islets of dog pancreas does not significantly alter the rate of production of elastase.

Group 1c (experiment). Twenty-four assays of pancreatic tissue in which both alpha and beta cells had been destroyed (method 2) showed no elastolytic activity, suggesting that destruction of the alpha cells is responsible for the failure of elastase production.

Group 2a (control). Seven assays of normal pancreatic tissue provided by experimental method 3 showed an average elastolytic activity of 0.36 mg per hour (S.D. = 0.12).

Group 2a (experiment). Seven assays of fibrosed pancreatic tissue from the same experiments showed no elastolytic activity, against the same elastin preparation.

Group 2b (control). Fifteen assays of normal pancreatic tissue showed an average elastolytic activity of 0.24 mg per hour (S.D. = 0.06).

Group 2b (experiment). Fifteen assays of fibrosed pancreatic tissue showed no activity against the same elastin preparation as in the control.

It appears, as described by Lansing, Rosenthal, and Alex (*7*) in teleost fishes, that the dog pancreas produces its elastase in the alpha cells of the islets. If the observation (*2*) that human atherosclerosis is associated with lowered elastase production by the pancreas is confirmed, it may be that atherosclerosis is a function of alpha islet cell failure.

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26 September 1955

Occurrence of 2-Hexenal in the Cockroach Eurycotis floridana

Eurycotis floridana (Walker), a large wingless cockroach, has been recorded in Georgia, Florida, and Mississippi, occurring in outdoor sheltered areas such as stumps, under signs, and the bark of dead trees (*1*). When alarmed, the adults, but not the nymphs, emit a secretion that has an odor which Hebard (*1*) has likened to that given off by the hemipteron, *Brochymena annulata* (Fabricius).

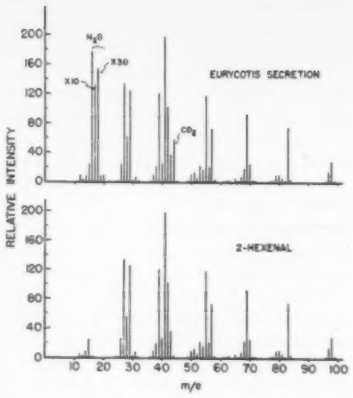

Fig. 1. Comparison of the mass spectra of 2-hexenal and the *Eurycotis* secretion.

In *Eurycotis*, the chemical is secreted by glandular cells into a large bilobed sac, where it is stored as a yellow liquid. The sac opens to the outside of the body medially in the intersegmental membrane between the sixth and seventh abdominal sternites. The location of this gland is similar to that found in *Blatta orientalis* (*2*).

When ejected, the volatile secretion from *Eurycotis* issues as a fine spray or as droplets that may be thrown for a distance of several inches. The secretion is toxic to the cockroaches if the insects are confined without suitable ventilation and made to emit the material. A similar toxicity occurs with the beetles *Tribolium* which are killed by their own odorous secretions (*3*), consisting mainly of ethylquinone (*4*). The *Eurycotis* secretion may be irritating if it gets on sensitive skin areas.

By means of mass spectrometry and infrared spectrophotometry, and the preparation of a chemical derivative, the *Eurycotis* secretion has been identified as 2-hexenal (*trans*). The sample, first analyzed in a Consolidated 21-103B analytic mass spectrometer, was prepared by simply dissecting out the reservoirs from adult males and females; some fatty tissue and parts of the sternites were also included. The sample was placed in a small tube that was attached directly to the inlet system of the mass spectrometer. The tube was cooled to – 180°C to condense the volatile components present, and then it was evacuated. The coolant was removed from the tube, and the condensed material was volatilized directly into the inlet system of the mass spectrometer. The first fraction collected at a pressure of 100 μ (volume of inlet system was 3 lit) was analyzed, as were a middle cut and the material present in the system at room temperature.

Structural analysis of the fragmentation pattern of the secretion showed that the material is a hexenal. Comparison of the spectrum of the secretion with the spectrum of various hexenals identified the secretion as pure 2-hexenal (Fig. 1). The secretion was contaminated only with CO_2 and H_2O, which condensed during the initial freezing from the air and from other tissues that were dissected with the glands. No trace of other impurities could be found. The CO_2 and H_2O may be mathematically removed from the spectrum of the *Eurycotis* secretion; the residue has a spectrum identical with that obtained from 2-hexenal. The spectra of the glandular secretions from male and female *Eurycotis* were identical.

The sample for infrared analysis was obtained by holding several males and allowing them to eject their secretion into carbon tetrachloride. The curve obtained was similar to that of synthetic 2-hexenal (Fig. 2) and further indicated the secretion is the *trans* form of the compound (*5*).

The 2,4-dinitrophenylhydrazone was prepared by allowing the cockroaches to eject their secretion into freshly prepared reagent (*5*). The melting point of the derivative was 139.5°–141.5°C, uncorrected (compare mp of 2,4-dinitrophenylhydrazone, 141°–142°C, *6*).

2-Hexenal was found to be one of the several carbonyl compounds responsible for the odor of whale oil (*6*). Other natural sources of this aldehyde are found in the plant kingdom. It is one of the constituents that make up the odor of Java citronella (*7*) and lavender oil (*8*). It forms part of the flavor of green tea (*9*), and the aroma of tea is primarily this compound (*10*). It has also been isolated from mulberry leaves (*11*).

Although nothing is known of the ene-

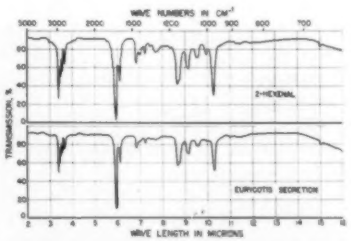

Fig. 2. Infrared spectra of 2-hexenal and the odorous secretion of *Eurycotis floridana*. Baird spectrograph with NaCl prism; samples in carbon tetrachloride solution; cell thickness, 0.1 mm and 0.418 mm, respectively.

mies of adults of *Eurycotis*, it is possible that 2-hexenal functions as a repellent or deterrent if the insect is attacked by a predator. Derivatives of 2-hexenal have been investigated as possible insecticides or insect repellents by the Orlando laboratories (*12*), and it is interesting to note that *Eurycotis* was using this compound long before man recognized a need for insect repellents.

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10 October 1955

Ultraviolet Absorption Spectra of Lichen Depsides and Depsidones

The two largest groups of aromatic lichen substances are classified as the depsides and depsidones. They consist of orcinol (5-methyl-1,3-benzenediol) and β-orcinol (2,5-dimethyl-1,3-benzenediol) derivative carboxylic acids joined by an ester linkage (depside) similar to digallic acid or by an ester and an ether linkage (depsidone) that binds the two rings. These unique metabolic products of lichens constitute 1 to 5 percent of the dry weight of the plant body, from which they may be extracted by ordinary chemical methods and purified by recrystallization (*1*).

In preparing the extracts for spectroscopy, it is difficult to find a suitable solvent. Depsides and depsidones are insoluble or barely soluble in many common nonpolar and polar organic solvents. Although acetone dissolves all of them, it is unfit as a solvent in ultraviolet. The substances could, however, be dissolved in 95-percent ethanol in concentrations of $10^{-4}M$, although not without danger of alcoholysis when prolonged heating was necessary. The absorbancy of the alcoholic solutions was measured on the Beckman model DU spectrophotometer (*2*).

The orcinol depsides have a characteristic bimodal spectrum of molar absorbancy in the range 240 to 330 mμ (Fig. 1*A*), which is shared even by orseillic acid, a common hydrolytic product of depsides, and the tridepside gyrophoric acid. Absorption maxima occur at about 270 and 307 mμ. Substitutions on the phenyl rings, as methoxyl in place of hydroxyl radicals, or the length of the alkyl side chains (CH_3— to C_7H_{15}—) have little effect on the position of λ_{max}. The β-orcinol depsidones also have bimodal spectra (Fig. 1*B*) with maxima near 238 and 312 mμ; absorbancy is much higher in shorter than in longer wavelengths. Curves of the β-orcinol depsides resemble those of β-orcinol depsidones although the absorption bands are not as sharp. The orcinol depsidones have poorly defined curves with a maximum at 245 to 255 mμ and a slight peak or leveling at 310 to 320 mμ (Fig. 1*C*). As a rule, increasing numbers of substituents, especially carboxyl or carbonyl radicals, exert a dampening effect on the absorption bands.

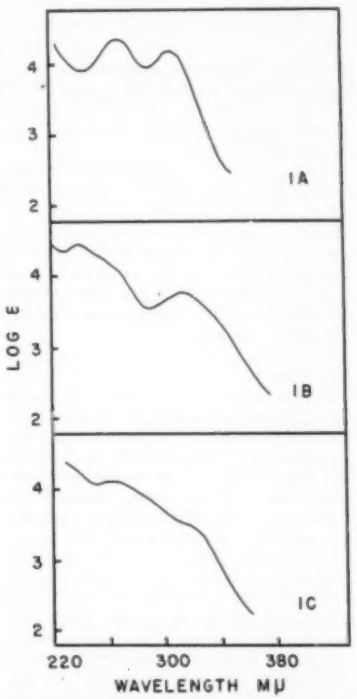

Fig. 1. Log molar absorption spectra for three lichen acids dissolved in 95-percent ethanol: (*A*) lecanoric acid, a common orcinol depside ($\lambda_{max.}$ 270 and 307 mμ); (*B*) salazinic acid, a common β-orcinol depsidone ($\lambda_{max.}$ 239 and 312 mμ); (*C*) physodic acid, an orcinol depsidone ($\lambda_{max.}$ 256 mμ).

These absorption spectra have provided a valuable means of identifying unknowns that are eluted from chromatograms and that are available only in minute quantities. Spectra of other lichen substances, such as the dibenzofuranes (*3*), quinones (*4*), and fatty acids, are completely dissimilar. Spectrophotometry will undoubtedly be an indispensable tool for analyses of precursors to the depsides and depsidones in pure cultures of the lichenized fungi (*5*) as well as for assays of the substances in chemotherapy (*6*).

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17 October 1955

The design of a computing device with intelligence enough to make mistakes and make a fool of itself, like a human being, is one ultimate goal in modern electronic computor design.—ROBERT K. PLUMB, *New York Times*, 24 Mar. 1955.

National Academy of Sciences

Abstracts of Papers To Be Presented at the Annual Meeting, 23–25 April 1956, Washington, D.C.

Certain Fundamental Events in the Menstrual Cycle

The generally accepted concept of the menstrual cycle is based on R. Schröder's studies of human uterine mucous membrane. Since normal human ovaries are rarely available, he used this target organ for seriation. Form changes in the glands were stressed and interglandular stroma neglected. Actually cyclic changes in the stroma influence the form of both glands and blood vessels. A superficial resemblance between the entire mucosa of late menstrual stages and the basal zone of other phases led him to believe that most of the mucosa is shed during menstruation. Assuming extensive postmenstrual regeneration, he emphasized mitoses in glands ("proliferative phase"), although mitoses in the stroma are not correspondingly abundant.

The study of monkeys with cycles essentially similar to human cycles has added materially to the understanding of the changes. Both ovaries and the uterus from a sufficiently large number of normal animals can be serially sectioned and seriated on the basis of ovarian developments, as Corner was the first to do. Adequate technical methods demonstrate dedifferentiation of stroma and arteries superficially resulting from vasoconstriction before and during menstruation. Loss of tissue fluids and reduction in cell size contribute more to the thinning of the mucosa than does the shedding of tissue. In the phase of repair, the restoration of stromal ground substance plays the major role.

Schröder's "secretory phase" was based largely on the enlargement and dilatation of glands by accumulated secretion. The production of secretion reaches its height during this phase, but the gland cells are active throughout the cycle. The difference is that in other phases the secretion is extruded and not stored. This can be correlated with differences in the activity of the myometrium.

GEORGE W. BARTELMEZ
Carnegie Institution of Washington, Baltimore

Gallium: Thermal Conductivity; Supercooling; Negative Pressure

And Gallio cared for none of those things. Acts 18: 17.

Gallium is a nonconformist among metals. It melts at 29.8°C, but its boiling point is about 2000°C. On cooling, it shows an utter disregard of its melting point and can be supercooled to −28°C without freezing, or 58°C below its melting point. Like water, it expands on freezing. In appearance, liquid gallium greatly resembles mercury.

The thermal conductivity of liquid gallium does not appear to have been previously measured. The method employed was a modification of that proposed by Benjamin Franklin and first used by Ingenhautz (1789) for comparing the thermal conductivity of two metal bars. Two glass tubes (30 cm long, 10-mm bore, 1-mm wall) were filled with pure mercury and gallium and were sealed. The upper ends of these tubes were inserted vertically through the bottom of a water boiler equipped with a heating coil, condenser, stirrer, and thermometer. The tubes were coated with a nonmetallic paint to insure the same thermal emissivity. Thermojunctions of fine wire that could be slid along the tubes served to establish points of equal temperature.

The relative thermal conductivity is theoretically equal to the *square* of the ratio of the distances of the two thermojunctions from the bottom of the boiler. The squared ratio of gallium to mercury was found to be 3.50 ± 0.05 or 0.081 cal/sec-cm-°C, computed from the known value of mercury at 60°C.

Supercooling was carried out by exposing droplets of liquid gallium on a sheet of paper in a slowly cooling deep-freeze chamber, equipped with a fan. Freezing was established when the spherical drops could no longer be distorted by a fine glass probe. The maximum supercooling observed was −28°C, or 58°C below its melting point.

The attempt to measure the negative pressure sustained by gallium was disappointing. To sustain a negative pressure, the liquid must adhere to the walls of the container. Although gallium clings tenaciously to a glass surface carrying an adsorbed layer of air, it does *not* wet the tube when the gas is removed. By partial pumping to retain some adhesion, it was found that, like water, the negative pressure decreased as the melting point was approached.

LYMAN J. BRIGGS
National Bureau of Standards

Effect on Endosperm Phenotype in Maize of Heterozygosity at the R Locus in the Staminate Parent

Normally, the gametes A and A′ arising from an AA′ individual, considered as a generalized monofactorial heterozygote, are precisely equivalent in their effects on the offspring to the corresponding gametes formed by the respective homozygotes, AA and A′A′. This rule was found not to hold in maize testcrosses involving an *R* allele (self-colored aleurone) and R^{st} (stippled aleurone).

A single RR^{st} plant, in a relatively uniform inbred strain, was self-pollinated. Pollen of the three classes of offspring, *RR*, RR^{st}, and $R^{st}R^{st}$ (distinguishable also by anther color) was placed on a highly inbred *rr* (colorless aleurone) stock. A determinate area of aleurone on each kernel then was scored quantitatively for pigmentation. Modal color grades (scale of 0–100) of the kernels on representative ears from the $rr♀ \times RR♂$ and $rr♀ \times R^{st}R^{st}♂$ matings were 98 and 23, respectively. The $rr♀ \times RR^{st}♂$ testcross gave a bimodal distribution with well-defined peaks at 3 and 18–23.

Verification of kernel genotype in the latter testcross requires a progeny test. It is obvious, however, that the score (3) for one kernel class, at least, derived from the heterozygote differs greatly from the value for the corresponding homozygote. Since the *RR* and $R^{st}R^{st}$ genotypes tested were offspring of a selfed RR^{st} plant, the change in endosperm phenotype associated with the heterozygosity appears to be transitory.

R. ALEXANDER BRINK
University of Wisconsin

Influence of Fluid Motions on the Free Decay of a Magnetic Field

The influence of fluid motions on the free decay of a magnetic field is investigated. It is shown that with suitable velocity fields the time constant for decay can be reduced or increased by large factors. Examples illustrating this phenomenon are worked out in detail; and applications to the problem of the origin of the earth's magnetic field and the growth and decay of the magnetic field of a sunspot are suggested.

S. CHANDRASEKHAR
Yerkes Observatory, Williams Bay

Duodenal Ulcer and the Hypothalamus-Pituitary-Adrenal Stress Mechanism

The fasting hypersecretion of gastric juice in duodenal ulcer patients has been attributed by us to excessive secretory activity of the vagus nerves. Recently, Gray and French have postulated an extravagal mechanism whereby stress produces a hypersecretion of gastric juice with ulcer formation. The hypothalamus is believed to be stimulated by mental and physical stress, and this, in turn, stimulates the pituitary and adrenal cortex. Cortisone, the end-product of this series of reactions, then acts directly on the gastric glands, producing a hypersecretion of hydrochloric acid. The experimental and clinical evidence presented in this paper fails to support these concepts.

The fasting nocturnal gastric secretion in a series of duodenal ulcer patients was measured three or four times previous to operation and then daily for the first 5 days after vagotomy and gastroenterostomy. In many patients an exaggeration of the usual hypersecretion of gastric juice occurred on the night before surgery, possibly owing to anxiety concerning the approaching operation. During the first 5 days after the operation, however, the fasting secretion remained below the level found in normal people in all cases. It is thus evident that this hypersecretion is abolished by vagotomy and that the release of cortisone by the trauma of the operation is not sufficient to stimulate the gastric glands.

In the laboratory Heidenhain pouches devoid of vagus innervation were prepared in dogs, and after control measurements of gastric secretion, artificial states of stress were produced by injecting insulin, epinephrine, cortisone, and ACTH. Even in large doses, no stimulation of secretion occurred. It is concluded that the fasting hypersecretion of gastric juice in duodenal ulcer patients is of vagus origin and is not due to the liberation of cortisone.

LESTER R. DRAGSTEDT, HERZL RAGINS, LESTER R. DRAGSTEDT II, SHIRL O. EVANS
University of Chicago

Effect of Temperature on the Long-Wave Limit of Photosynthesis

Measurements made by Emerson and Lewis [*Am. J. Botany* **30**, 165 (1943)] at 10°C showed a sharp drop in the efficiency of *Chlorella* photosynthesis in the wavelength region just beyond 685 mμ. The results shown in their Fig. 5 indicate that at 700 mμ the efficiency was less than half the value at 685.

Our measurements show that at higher temperatures the decline begins at shorter wavelengths than at lower temperatures. For example, at 20°C we have observed a 50-percent drop in efficiency between 650 and 685 mμ, while at 5°C the efficiency remained nearly constant from 650 to 685 mμ, and the 50-percent drop came between 685 and 710 mμ.

We have found this temperature dependence of the long-wave limit of photosynthesis with both *Chlorella pyrenoidosa* and *Porphyridium cruentum*. However, it seems to be characteristic of low intensities of light. If the low-intensity light beam of measured energy is supplemented by a more intense (unmeasured) beam, then the efficiency of the small increment of measured light remains nearly constant out to 685 mμ, even at a temperature of 26°C. The supplementary beam is effective whether it is made up of a mixture of longer and shorter wavelengths, or whether is includes only red light of wavelengths longer than 650 mμ.

Blinks and Haxo [*J. Gen. Physiol.* **33**, 389 (1950)] observed that with algae containing phycobilin pigments the efficiency at 685 mμ was low. From this they concluded that in these organisms the light absorbed directly by chlorophyll was relatively ineffective in photosynthesis. We suggest that at the temperature of their experiments, 685 mμ may have been beyond the long-wave limit for full efficiency at low light intensity. Our measurements with *Porphyridium* indicate that at shorter wavelengths the efficiency of light absorbed by chlorophyll is normal.

This work was supported by grants G-27 and G-1398 from the National Science Foundation.

ROBERT EMERSON, RUTH CHALMERS, CARL CEDERSTRAND, MARCIA BRODY
University of Illinois

Restricted Random Walk in Transport

Einstein found for the diffusion coefficient D and viscosity η the relationship

$$D\eta = \frac{kT\,dlu\ a}{6\pi r\,dlu\ c} \qquad (1)$$

It was obtained by equating the Stokes hydrodynamic equation for the force on a sphere to the negative of the gradient of the thermodynamic potential. For self-diffusion, one finds by relaxation theory for the viscosity, $\eta = kT/\lambda^2 k'$ and for the diffusion coefficient

$$D = \frac{\lambda^2 k'}{\zeta}\,\frac{dlu\ a}{dlu\ c}$$

Whence,

$$D\eta = \frac{kT}{\zeta\lambda}\,\frac{dlu\ a}{dlu\ c} \qquad (2)$$

k, T, r, λ, c, a, k', and ζ are the Boltzmann constant, absolute temperature, radius of the sphere, lattice spacing, concentration of diffusing particles, their activity, frequency of forward jumping by a lattice distance, and the number of viscous shearing motions required to advance a diffusing molecule one lattice distance, respectively.

As is anticipated, ζ comes out near 6 for normal liquids. This corresponds to the number of nearest neighbors in the same plane in hexagonal close packing. The diffusion coefficient D_ζ for the center of gravity of a cloud composed of ζ independently diffusing molecules is likewise

$$D_\zeta = \frac{\lambda^2 k'}{\zeta}\,\frac{dlu\ a}{dlu\ c} \qquad (3)$$

where

$$D_1 = \lambda^2 k'\,\frac{dlu\ a}{dlu\ c}$$

is the diffusion coefficient of a single molecule. Thus, a long flexible molecule composed of ζ kinetic segments should obey the relationship $D\zeta = D_1/\zeta$. Here, D_1 is the diffusion coefficient of a kinetic segment and $\zeta \sim M$, whereas for the compact sphere of Einstein $D \sim M^{-1/3}$ where M is the molecular weight. The viscosity of complex liquids can be expressed by

$$\eta = \frac{\sum_i}{i}\,\frac{\chi_i\beta_i}{\alpha_i}\,\frac{sinh^{-1}\beta_i\dot{s}}{\beta_i\dot{s}}$$

where χ_i, β_i, α_i and $\dot{s}$ are the fraction of the shear surface covered by the ith units, the relaxation time, the reciprocal of an intrinsic pressure, and the rate of shear, respectively. These parameters are predictable from structure.

HENRY EYRING, TAIKYUE REE, THEODORE EINWOHNER
University of Utah

Brain Fuel and Function

The central nervous system, according to current thought, normally obtains its energy, for maintaining integrity and for active function, by burning sugar with oxygen. The energy is presumably fed into the cell machinery via high-energy phosphate esters. Recent work with Abood showed that the well-known fall in concentration of these esters during activity is—for muscle, nerve, brain, and brain mitochondria—more a result of decreased synthesis than of increased breakdown and, therefore, does not represent a quick energy release.

We have found that perfused brain (cat) can continue active, can even be convulsed, with no use of extrinsic or intrinsic carbohydrate sources; indeed, convulsions are possible with no increase in oxygen consumption, much as conduction in azide-poisoned nerve continues without increased oxidations. In perfused or normal brain, moreover, activity evoked by convulsive drugs or currents or by afferent nerve stimulation is associated with a breakdown of lipo- and nucleoprotein, which is associated with a reversible decrease in microsomes, and an increase of amino nitrogen in the effluent. The perfused brain gradually fails to take up glucose, produces much lactate, and fails in electric and reflex action. Addition of nucleic pyrimidines, particularly uridine and cytidine, like inclusion of liver in the perfusion circuit, prevents or reverses these changes and replenishes the galactosides and phosphatides that had earlier decreased. These nucleosides also prevent or reverse the loss of function and severe vasoconstriction produced by ATP addition. The catalytic action of uridine on galactose formation and of cytidine on that of phospholipids is relevant to their role in relating fuel to function in brain.

R. W. GERARD
A. GEIGER
University of Michigan

Mechanism of Growth Control in Liver Regeneration

Tissue-culture studies have shown a comparable outgrowth in a high concen-

tration of serum from partially hepatectomized rats and in a low concentration of normal serum. A high concentration of normal serum showed inhibitory effects. These findings were considered to indicate an inverse relationship between the concentration of certain serum constituents and liver growth [Glinos and Gey, *Proc. Soc. Exptl. Biol. Med.* **80**, 421 (1952)].

Evidence *in vivo* supporting this concept was obtained by showing that cell division can be induced in the resting liver by lowering the concentration of serum constituents through plasmapheresis and can be inhibited in the regenerating liver by increasing the concentration of serum constituents through fluid intake restriction. Electrophoretic analysis of serum proteins, undertaken as a first step toward identification of the serum constituents involved, showed decreased albumin concentrations when liver cells were dividing and normal or increased concentrations when cell division was inhibited. Histochemical investigation of the organization of cytoplasmic ribonucleoprotein in the regenerating liver showed changes beginning within 30 minutes after partial hepatectomy.

The changes are indicative of increased protein synthesis and proceed from the periportal to the centrilobular areas. Cell division follows the same topography but with a lag of from 16 to 24 hours. The nature of these changes and their spatiotemporal distribution suggest that postoperative local circulatory factors accelerate and accentuate the appearance of concentration changes in the interstitial fluid similar to those in the serum.

These observations lead to the conclusion that a negative feedback system operates in controlling liver regeneration. Further plans for elucidating the possible participation of albumin and the role of the interstitial fluid in the system, as well as the relationship of such a mechanism to Weiss' concepts of growth control, are discussed.

ANDRÉ D. GLINOS
Walter Reed Army Institute of Research

Heat Conductivity in Polyatomic Gases

The assumptions implicit in the Eucken relation for the thermal conductivity of a polyatomic gas are discussed. It is found that under ordinary conditions it would be more reasonable to take for the correction for the internal degrees of freedom of the molecules the factor $(2/5)((C_v/R)+1)$ at very high temperatures. A generalization of the Eucken relation is given to take into account dissociative equilibria and the variation of the collision diameter of the molecules with electronic excitation.

JOSEPH O. HIRSCHFELDER
University of Wisconsin

Induction of Normal Structures in Embryos and of Tumors in Larvae of Amphibians

A crucial question in embryology is to what extent external stimuli specify biological reactions. Is it the specificity of the stimuli or rather the selectivity of response of the organic systems that determines the outcome? This question becomes acute in instances such as egg activation, embryonic induction, and carcinogenesis. Normally, egg development is initiated by the sperm; neural and other structures are induced by adjacent tissues; some cancers can be correlated with specific genes. However, any one of these phenomena can be equally well produced by applying physical or chemical stimuli. The complexity of the situation is indicated by the following facts. (i) One and the same stimulus may have entirely different effects, varying with the age of the treated organism. (ii) Many, quite unrelated, stimuli may elicit the same biological response when applied to the same developmental stage.

In an attempt to clarify these problems, experiments were performed using well-known carcinogenic chemicals as stimuli and different developmental stages of amphibians as reactors. When they were acting on early embryonic stages, the implanted carcinogens induced the formation of normal structures, such as ear vesicles, adhesive glands, pronephric tubules; but when they were acting on larval stages, they initiated cancerous growth of various kinds. Obviously the kind of morphogenic response is determined by changes of competence of the reacting tissues rather than by the kind of artificial stimuli applied. Emphasis must be placed on investigation of the reacting time-space controlled biological systems rather than on the initiating stimuli which in a merely remote sense control development.

JOHANNES HOLTFRETER
University of Rochester

Mumps and Newcastle Virus Reproduction

Mumps and Newcastle virus particles can be counted by enumeration procedures developed in this laboratory for influenza A and B viruses. Each virus is adsorbed by erythrocytes; the number of particles that have the hemagglutinating property can be determined photometrically. One particle of each can infect; the number of infective particles can be determined in embryonated eggs. Under controlled conditions, preparations of each virus are obtained with hemagglutinating to infective particle ratios approaching 1.0. Electron microscope counts correspond with the number of hemagglutinating particles.

The infective property of mumps, like that of influenza A and B viruses, is unstable; the half-life is about 80 minutes at 35°C. Newcastle virus is less unstable; at 35°C the half-life is about 10 hours. The hemagglutinating property of the four viruses is relatively stable; with each the half-life at 35°C is longer than 16 hours.

New particles of mumps virus are not released before 24 hours. With Newcastle, as with influenza A and B viruses, new particles appear in less than 3 hours. With mumps, during the constant phase of logarithmic increase, the time to double the number of particles is about 15 hours, while with Newcastle, influenza A and B viruses it is about 45 minutes. The maximal yield of mumps per allantoic cell is about 50 particles, but with Newcastle, influenza A and B viruses it is about 1000 particles.

Initial particle-cell ratios of 3 or more cause alterations in the reproduction of mumps, influenza A and B viruses. Most striking is the emergence of a high proportion of hemagglutinating but noninfective particles. This does not occur with Newcastle virus, even when the initial particle-cell ratio is 40.

FRANK L. HORSFALL, JR.
Rockefeller Institute for Medical Research

Endocrine Influences on Growth of a Benign Transplantable Mammary Tumor

This mammary adenofibruma consisting of an interlacing canal system of mammary ducts is unique among the experimental mammary tumors in that its growth rate can be enhanced or depressed by appropriate endocrine modifications. The rate of growth is uniform and vigorous in intact female rats and is depressed by ovariectomy.

Experiments were conducted on its growth in hypophysectomized rats in which the tumor grows slowly and progressively. Its growth is not stimulated by estrone, progesterone, or by the lactogenic or growth hormones of the pituitary, administered separately. Estrone and progesterone in combination moderately elevate its growth rate; supplementing these steroids with growth hormone restores the growth rate of the tumor to that occurring in intact females, whereas lactogenic hormone is ineffective in this regard.

CHARLES HUGGINS
YOLANDA TORRALBA
ANNA CHARR
University of Chicago

Solutions for the Propagation of Waves through a Lattice of Spherical Scatterers

Solutions are obtained for the multiple scattering of waves in a lattice of scattering spheres. It is assumed that the index of refraction (or the potential, for electron waves) depends only on r inside each sphere and is constant between the spheres and that all spheres are equivalent, of radius a. Use of Green's theorem and the requirement that the solution at the nth sphere be $\exp(i\mathbf{K}\cdot\mathbf{R}_n)$ times the solution at the sphere at the origin leads to a rapidly convergent set of simultaneous equations for the coefficients F_{ml} of the expansion of the wave function at the spherical surface in spherical harmonics Y_{ml}. From these coefficients the nature of the wave inside and between the spheres can be computed. Roots of the related secular equation give allowed values of k^2 (the electron energy or the acoustical frequency squared) as func-

tions of the vector **K**. The advantage of this formulation is that the secular equation relates two separated sets of functions: (i) the usual phase angles $\delta_l(k)$ for scattering from a single sphere, which depend only on the spheres' interiors and not on the lattice; (ii) a new set of functions M_{ml} (**K**, k) that depend only on the lattice and not on the spheres' interiors. Tables of the M's are being computed by machine for simple cubic and for face and body-centered cubic lattices, for different magnitudes and directions of **K** and different values of k^2. As functions of the propagation vector **K**, they exhibit the typical periodicity of the Brillouin zones; they have simple poles at $k^2 = |\mathbf{K} + \mathbf{K}_v|^2$ where $\mathbf{K}_v$ is the vth vector for the reciprocal lattice. Solutions for the lower Brillouin zones can be obtained graphically. A few examples will be given of how the solutions change with **K**, with the ratio between a and the lattice spacing and with changes in the index of refraction (or electronic potential) inside the spheres.

PHILIP M. MORSE
Massachusetts Institute of Technology

Eohelea Stridulans, a Striking Example of Paramorphism in a Baltic Amber Gnat

Examples of similar structures in widely separated and quite unrelated animals, suggesting independent, parallel development along the same lines, are numerous and have been often discussed. The case of *Eohelea stridulans* is especially interesting, because it is unique in the order Diptera, whose members lack organs of stridulation and produce sounds in a totally different manner. *Eohelea* is the first representative of Diptera ever found that possesses stridulating organs comparable to those common in such Orthoptera as crickets and katydids.

As in species of *Ephippigera*, in which an almost identical stridulating apparatus is present on both forewings, *E. stridulans* has also a similar apparatus on both wings. But whereas in crickets and katydids the apparatus is situated near the base of the wing, in *E. stridulans* it is at the end of it. It is composed of 15 parallel ridges having a series of short, lateral branches on each side of each ridge. From the position of the ridges on the wings, one must conclude that the sound is produced by friction, not of the ridges themselves, but of these lateral branches. This excludes a homology between the sound-producing organs of Orthoptera and those of *Eohelea*, which also lacks a localized vibrating membrane or tympanum.

Since Orthoptera are very distantly related to Diptera, it is certain that the unique case of a stridulating apparatus in *Eohelea* developed independently. It seems probable that such development may take place when the prerequisite mechanical and physicochemical building stones are available so that the process may be started by some casual stimulation, while the completed structure is a result of the adequacy of its function.

ALEXANDER PETRUNKEVITCH
Yale University

Role of Structural Defects on Some Properties of Semiconductors

Properties of semiconductors can be greatly influenced by very small concentrations of chemical impurities and structural defects. For this reason, rigid requirements are placed on the degree of perfection in semiconductor crystals for research and for use in devices.

In this paper, a brief account will be given of some recent work directed toward evaluating the role of primary structural imperfections and their interactions on some properties of semiconductors. The discussion will include the origin and control of edge dislocations in the growth of silicon and germanium crystals from the melt, and the effect of variations in the density of this imperfection on carrier lifetime, some mechanical and surface properties, and on the kinetics of copper precipitation in germanium. Some discussion will also be devoted to radiation damage effects induced by electrons in crystals of germanium, silicon, and cadmium sulfide and the removal of these effects by annealing.

F. D. ROSI
R.C.A. Laboratories, Princeton

Origin of the Magneto-Ionic Expander Isotope Separator

The magneto-ionic expander followed 13 years of unsuccessful development of the ionic centrifuge, a form of isotope separator similar to the calutron, or the mass spectrometer. Unlike these devices, which operate at inherently high voltage, more than 50,000 volts for uranium, and which are unstable at woefully low currents of ions, the magneto-ionic expander operates at an effective voltage of less than 100 volts and has no current instability whatsoever. It offers isotopes of metals on a large scale less expensively than any other method I know of.

The manner of failure of the ionic centrifuge is instructive. A short electric arc is drawn between metallic electrodes in a parallel magnetic field and subjected to a negative perpendicular radial electric field. No negative electrons should move against this field. No positive ions should reach a cylinder at the radius r, until the potential reaches the Larmor value at r,

$$V(r) = -\frac{e}{mc^2} H^2 r^2$$

m being the mass of the positive ion. V could then be chosen so that only the ion of larger mass would be caught.

But the facts were otherwise. Negative electrons do travel out against the opposing electric field, even to an *insulated* cylinder at r. The negative potential of such an insulated cylinder will rise until it reaches the Larmor value; it receives approximately one-half of the total current of positive ions, plus electrons; the impoverishment of its deposit is less than $\delta m/2m$ irrespective of the magnitude of V. These facts led to the magneto-ionic expander isotope separator.

JOSEPH SLEPIAN
Westinghouse Research Laboratories

Dielectric Relaxation Times and Shapes of Rigid Molecules

The dielectric constants and losses of a number of liquids composed of rigid molecules have been measured at microwave frequencies and used to calculate the molecular relaxation times. The values thus obtained are combined with those already in the literature to study the effects of liquid viscosity, molecular size and shape, and dipole orientation in the molecule upon molecular relaxation time.

The results show a tendency of the molecular relaxation time and the viscosity to increase with increase in molecular size in a pure liquid and of the relaxation time to increase with viscosity, as required by the Debye theory. However, many exceptions to this tendency occur, and it is possible that apparent increase in relaxation time with viscosity is simply the result of increase in molecular size, which also increases the viscosity.

Although the attachment of a methyl group to a ring may not impede viscous flow and may even facilitate it, its protrusion impedes the molecular rotation necessary for orientation in an applied field and thus lengthens the relaxation time. The orientation of a dipole in an unsymmetrical molecule determines the most probable direction of rotation of the molecule and thus influences the relaxation time. When polar molecules are surrounded by nonpolar, their relaxation times are influenced by the nature of the nonpolar molecules as well as by the viscosity of the liquid as a whole. If the polar molecules are nearly spherical, the effect of the liquid viscosity is small.

CHARLES P. SMYTH
Princeton University

Histocompatibility Genes

Tissues grafted between identical twins or members of an inbred strain (isografts) are accepted by the host; tissues grafted between nontwins or from one inbred strain to another (homografts) are almost always resisted by the host and are usually rejected. Resistance to homografts is due to genetic differences between donor and host. The genes concerned are called histocompatibility genes.

Methods have been devised for the analysis of histocompatibility genes in the mouse. One method involves the use as "markers" of known genes linked with histocompatibility genes. A second method, involving a greater investment of time but having wider applicability, depends on the production by an appropriate series of crosses of isogenic resistant lines. These are lines identical with standard inbred strains except for the substitution at one locus of a gene causing resistance to grafts from the inbred strain. The isogenic resistant line and its inbred mate constitute a coisogenic pair, essentially identical except for a difference at one histocompatibility locus. By appropriate crosses, followed by inoculation of the hybrid with a suitable transplant (transplantable tumor), the gene differentiating the members of any coisogenic pair can be determined.

Three histocompatibility loci have been identified, *H-1* on chromosome I, *H-2* on chromosome IV, *H-3* on chromosome V. Eleven alleles (or pseudoalleles) are known at *H-2*. *H-1* and *H-3* are "weaker" than *H-2*; skin grafts between coisogenic strains differing at *H-1* or *H-3* survive longer than similar grafts between strain pairs with an *H-2* difference (Counce and Snell).

GEORGE D. SNELL
Roscoe B. Jackson Memorial Laboratory

Calculating the Loudness of Noise

The calculation of the apparent loudness of a complex noise from measurements of sound pressure levels in octave bands depends on the solution of three problems: (i) how loudness varies with the intensity of a sound; (ii) how loudness varies with the bandwidth of the spectrum; (iii) the form of the equal loudness contours for octave bands of noise.

The subjective loudness of a 1000-cycle tone and of bands of noise of medium and high frequency increases as a power function of the physical intensity of the sound. The loudness in sones, S, is related to the level in decibels, P, by the formula, $\log_{10}S = 0.03P - k$, where k is a constant. The loudness of low-frequency sounds grows more rapidly with level.

When equally loud octave bands are combined to form a wide-spectrum noise, the over-all loudness is a linear function of the number of bands. When unequal bands are combined, the total loudness S_t of a complex noise is given by

$$S_t = S_m + 0.3(\Sigma S - S_m)$$

where S_m is the loudness of the loudest octave band and ΣS is the sum of the loudnesses of all the bands.

From a determination of the form of the equal loudness contours for octave bands of noise, a chart has been constructed to relate the loudnesses of the several bands to sound pressure level. By means of this chart, physical measurements of a sound spectrum can be converted to loudness per octave band, and from these loudnesses the total loudness of the noise can be computed by the foregoing equation. This loudness in sones can be converted to loudness level in phons by the formula, $\log_{10}S = 0.03P - 1.2$.

S. S. STEVENS
Harvard University

Radiometry of Mars and Venus

This paper reports the distribution of infrared emission over the face of the planets and their spectra, both measured in the spectral region to which our atmosphere is relatively transparent, 8–14 μ. The scanning spot was 1.4 seconds in diameter, while the spectra of radiations from the disk as a whole exhibit 0.1-μ resolving power. Local black bodies served to calibrate radiometer response; and measurements on the moon served to account for our atmospheric transmission.

Both dark and sunlit hemispheres of Venus were at approximately −40°C. The local noon temperatures on Mars were 25°C for light areas and 33°C for dark areas. Minimum night temperatures are estimated as −70°C.

Equatorial scans across Venus in 1953 gave a slope of 5° per diameter of the planet across the evening terminator, and 1954 measurements across the morning terminator indicated a reversed slope and a direct sense of planetary rotation as a consequence, but the measurements of 1954 do not conclusively establish it.

Scans across Mars show a maximum temperature ½ hour after noon, indicating a surface thermal diffusivity higher than that of the moon but not as high as loam on the earth.

Spectra of Venus and Mars are dominated by telluric absorption. When reduced to outside our atmosphere, neither spectrum reveals any strong features, such as might be expected from the bands at 9.4, 10.4, and 12.6 μ, owing to the great CO_2 content of Venus.

We are grateful to I. S. Bowen for granting us use of the California telescopes; and we acknowledge Office of Naval Research support.

JOHN STRONG
WILLIAM M. SINTON
Johns Hopkins University

Phototropism of the Avena Seedling in the Ultraviolet

Avena sativa seedlings curve toward a source of ultraviolet light with a response that is not limited to the tip but is distributed over the whole seedling. Irradiation of limited zones shows that maximum sensitivity occurs in the region below the tip and around the mesocotylary node. The curvature is proportional to the logarithm of the applied energy. Its action spectrum shows a peak at 297 mμ with a shoulder at 280 mμ, and a trough at about 260 mμ. This excludes the participation of riboflavin as a detecting pigment in these curvatures. The significance of the action spectrum will be discussed.

KENNETH V. THIMANN
GEORGE M. CURRY
Harvard University

Hydrogenase in Biological Nitrogen-fixing Agents

Hydrogenase from *Clostridium pasteurianum* has been purified from the "soluble" fraction (supernatant from centrifugation at 144,000 × g of the material obtained after disintegration of the cells). Examination of the most purified material in an analytic centrifuge revealed a major and minor component. The enzyme was estimated to be about 80-percent pure; the spectrum contained a pronounced flavin peak. A partially purified preparation subjected to electrophoresis at *p*H 7.0 in 0.05*M* phosphate possessed 14 components, two of which contained flavin. One of these contained all the hydrogenase activity.

Difference spectra of whole cells of *Azotobacter vinelandii* established that H_2 will reduce intracellularly pyridine nucleotides, flavins, and cytochrome components, and that N_2 will oxidize a cytochrome-*b*-like pigment and a flavin. Hydrogenase in the azotobacter is particulate; attempts to purify it sufficiently to make studies similar to those that have been so revealing with the clostridial enzyme have been only partially successful. Application of methods for fractionation of mitochrondia provided a fraction containing hydrogenase that responds to ferrous ions (ferricyanide as acceptor) and is inhibited by phosphate.

The mechanism of H_2 activity in the symbiotic system has been obscure, for attempts to demonstrate a hydrogenase here have been unsuccessful. Recently, an enzyme preparation has been made from soybean nodules that reveals definite difference spectra between H_2-O_2, H_2-N_2, and H_2-vacuum. The results suggest that H_2 activated by such preparations reduces hematin compounds, and that N_2 specifically oxidizes a flavin component.

PERRY W. WILSON
University of Wisconsin

From the lazy method of philosophizing in the closet, among books and diagrams, there never arose, there never will arise, any discovery of consequence: Great inventors usually understand the extent of their own principles too well, to leave much of the application of them to others.—THOMAS MELVILLE, "Observations on Light and Colours," *Essays and Observations, Physical and Literary* (Philosophical Society, Edinburgh, 1756), vol. II, pp. 12–90.

Book Reviews

The Extra Pharmacopoeia. vol. 2. Pharmaceutical Press, London, ed. 23, 1955. xxxi + 1501 pp. £2 17s. 6d.

Volume II of *The Extra Pharmacopoeia* supplements the information in the first volume published in 1952, and the two volumes form a comprehensive work of reference on materia medica and allied subjects. The first edition of this reference work, published by William Martindale in 1883, consisted of 313 pages. The advances in therapeutics may be gaged in part by the size of the present volumes: volume I, 1532 pages, and volume II, 1501 pages.

The Extra Pharmacopoeia is unique in its outlook among references on materia medica. It compiles in concise form information concerning medicinal substances of preparations and alterations in standards, existing substances that differ materially from British standards. It covers the latest developments in medicine and the allied sciences and incorporates relevant information in the form of brief monographs or abstracts. Volume I is largely limited to a product description under an alphabetical arrangement.

Volume II, arranged in 33 sections, has been compiled for the general practitioners in pharmacy and medicine, for experts engaged in associated activities, for research workers, and for students. For the general practitioner of medicine and pharmacy, the volume provides much information of use and interest. For analysts, clinical pathologists and biochemists, the sections dealing with chemical and physical methods for the analysis of drugs, food, and water and with clinical biochemistry and hematology provide detailed descriptions of selected methods. Sample section headings indicate the broad scope of this work, for example, polarographic analysis, indicators, graphic analysis, fluorometric analysis, microbiological assay of vitamins, food analysis, food law, water analysis, structure-action relationships, sterilization, radiotherapy, vitamins, clinical biochemistry, and proprietary medicines.

The new edition of *The Extra Pharmacopoeia,* prepared with the help of many experts, is a valuable reference work for scientists and technologists in the fields of pharmacy and medicine as well as related areas of work. The content of the book is made more valuable by thousands of abstracts of, and references to, scientific papers that serve as a guide to published work on the various subjects. The work is so broad in its scope that it deserves a place in every scientific library.

GLENN L. JENKINS
Purdue University

Industrial and Manufacturing Chemistry. Part I, *Organic*; part II, *Inorganic,* vols. I and II. Geoffrey Martin. Philosophical Library, New York, 1955. Part I, xxi + 752 pp., ed. 7; part II, vol. I, xxiii + 600 pp., ed. 6; part II, vol. II, xxi + 491 pp., ed. 6. $50 per set.

An editor of a scientific or technical journal or journals possibly is more aware of the invaluable services of comprehensive and authoritative reference volumes than most others engaged, in one way or another, in highly specialized areas of the physical sciences.

With four journals serving a very broad spectrum of chemical science and technology to watch over, I find such greatly diversified reference works as the 15-volume Kirk and Othmer *Encyclopedia of Chemical Technology,* the four-volume Mattiello *Protective and Decorative Coatings,* the six-volume Guenther, *The Essential Oils,* and the six-volume Haynes, *The History of the American Chemical Industry,* highly informative and great time savers. Otherwise how would I check thousands of points a year that need checking in manuscripts? How could I answer the flood of calls for aid for generalized information from all parts of the world?

To the meager list just cited, and to a great many more reference works that could be mentioned if space permitted, must be added the three-volume *Industrial and Manufacturing Chemistry* published in England.

This very important source of information on many varied facets of industrial chemistry and chemical engineering is by no means a new venture. A continued demand for Martin's *Industrial Chemistry* for the past two decades has demonstrated the intrinsic value of these reference volumes.

Volumes I and II (inorganic) are now in a sixth edition, and a third volume, dealing with organic chemistry and more particularly standard chemical and chemical process manufacturing operations now in a seventh revision or edition.

Frankly, the task of describing (perhaps the word *identifying* is more correct) this reference series is unnecessarily complicated—at least I feel this to be the case. The inorganic field is covered in two volumes—labeled "Volumes I and II." The organic field, with stress on manufacturing, is covered in a separate book which, unfortunately, is labeled as "Part I," rather than as "Volume III." Obviously, there is a historical reason for this complexity, but need this condition continue indefinitely? Despite this criticism, the quality of the text material presented in the three books warrants high praise.

In the preface to the first edition of part I, the original editor, Geoffrey Martin, stated "The editor's aim has been to cover the whole range of subjects with which the industrial chemist and manufacturer are usually concerned, and the book will serve either as a textbook or as a work of reference; it is intended to meet the requirements of all business and practical men interested in chemical processes, of manufacturers, consulting chemists, chemical engineers, patent workers, inventors, technical lawyers. . . . ."

A careful perusal of the recently revised editions indicates that all three volumes have been subjected to a rigorous reevaluation of content, with the result that the information and data presented have been updated. It is then a fair statement to say that modern manufacturing operations and chemical technology as practiced both in Europe and the United States are given with reasonable accuracy. The editors readily admit (and wisely so) that intimate know-how is not provided.

Space does not permit a detailed report regarding what has been added in the most recent editions and what has been omitted. However, to one who can say, without stretching the bonds of modesty too greatly, that he is reasonably cognizant of the chemical and technologic changes of the postwar years, the new editors have done a commendable job of modernizing the latest editions.

It is my belief that these books will find their greatest appeal to technical librarians in the United States, com-

panies in the chemical and chemical process industries, and the librarians of colleges and universities offering degrees or even courses in industrial chemistry and/or chemical engineering.

The paper, printing, and binding are satisfactory for books that will be referred to with considerable frequency.

WALTER J. MURPHY

American Chemical Society

The ISCC–NBS Method of Designating Colors and a Dictionary of Color Names. NBS Circular 553. National Bureau of Standards, Washington, 1955. v + 158 pp. $2. (Order from Supt. of Documents, Washington, 25.)

To both the Inter-Society Color Council and the National Bureau of Standards we are indebted for the development and publication of the *ISCC-NBS Method of Designating Colors.* It is an outcome of problem 2 brought to the Inter-Society Color Council in 1932 by its first chairman, the late E. N. Gathercoal, who represented in the council the *U.S. Pharmacopoeia.* Indeed, it was the problem of naming colors in the *U.S. Pharmacopoeia* and the *National Formulary* of the American Pharmaceutical Association that led Gathercoal, as a part of the 1930 decennial meeting of the USP Revision Committee, to prepare a 90-page printed report on the subject of color names and call for a special color exhibit and a meeting of color experts to decide whether something might be done to find "a means of designating colors in the *United States Pharmacopoeia,* in the *National Formulary,* and in the general pharmaceutical literature. . . . such designation to be sufficiently standardized as to be acceptable and usable by science, sufficiently broad to be appreciated and used by science, art, and industry, and sufficiently commonplace to be understood, at least in a general way, by the whole public."

One result of this exhibit and meeting was to lead to the formation of the Inter-Society Color Council, and the problem of color names, common to all its member bodies, was referred to a Committee on Measurement and Specification, under the chairmanship of the late I. H. Godlove. The 1933 report of this committee outlined a recommended system of color designations that was approved by the council and has been followed by subsequent committees, including the authors of the present report, in developing the system of color designations and in settling the color boundaries. In 1939 the ISCC formally approved and recommended to the N. F. Revision Committee and to the U.S.P. Convention, the method described in NBS research paper RP 1239, written by Deane B. Judd, physicist at the National Bureau of Standards, then chairman of the Committee on Color Problems of the ISCC, and Kenneth L. Kelly, then research associate at the National Bureau of Standards, representing the American Pharmaceutical Association.

Following this 1939 publication, a number of suggestions for revisions were received, particularly from textile groups in the Inter-Society Color Council, and a revision committee was formed in 1947 to study these suggestions and to make recommendations on the name and boundary changes that would make the method more generally applicable in all fields. (Incidentally, it may be of interest to mention that 30,000 copies of the RP 1239 report were sold. This is quite a record for a technical report and shows how real the interest is in this subject.) The changes embodied in the present publication were approved in 1949 by voting delegates of all 19 groups that were at that time member bodies of the ISCC.

The method adopted is simple in principle. The terms *light, medium,* and *dark* designate decreasing degrees of lightness, and the adverb *very* extends the lightness scale to "very light" and "very dark." The adjectives *grayish, moderate, strong,* and *vivid* designate increasing degrees of saturation. These and a series of hue names, used both as nouns and in adjective forms, are combined to form names for describing color in terms of its three perceptual attributes: hue, lightness, and saturation. Certain adjectives cover combinations of lightness and saturation, as *brilliant* for "light, strong," *pale* for "light, grayish," and *deep* for "dark, strong."

The relationship of the names can be explained most easily by reference to what is known as a color solid in which the three dimensions are hue, lightness and saturation; *hue* extends in a circular direction about the neutral axis, clockwise from red through the hues in spectrum order back to red; *lightness* extends in the vertical direction from black at the bottom through a series of grays to white at the top; and *saturation* extends in a radial direction horizontally from the central neutral axis at which the saturation is zero out to their strongest saturation, as far as they may extend from the central axis. There are 267 ISCC-NBS name blocks in the complete system, and each defines a block in the color solid. This number is sufficient for naming colors from memory, but since it is estimated that man can distinguish more than 10 million surface colors, it means that each name block contains a number of distinguishable colors.

The important thing about this method that distinguishes it from all others is that the boundaries of each name designation are fixed. In fact, it is a revision of some of the 1939 boundaries that made this present report necessary. The limits are defined in terms of the Munsell color notation, so that each color designation, consisting of a hue name and modifiers, defines a block in the color solid bounded by vertical planes of constant hue, horizontal planes of constant value, and cylindrical surfaces of constant chroma. Table 1 (p. 4) contains all the hue names and abbreviations used in the ISCC-NBS system, and Fig. 2 (p. 3) shows the scheme of hue modifiers, the "-ish" grays and the neutrals with their modifiers.

The method makes it possible to describe any color in a way that can be understood. It does not provide for pinpointing colors, either in fashion or colorimetry or for any other purpose; but for fashion color names it does provide an understandable descriptive term; and for colorimetry, when it is important to make close distinctions among the thousands of colors that in this system might bear identical designations, resort must be had to one of the several numerical specifications available today that are well standardized—for example, the internationally recognized CIE colorimetric coordinate system or the Munsell notation as smoothed and recommended by the Optical Society of America's 1943 report of the Subcommittee on Spacing of the Munsell Colors.

The report is a book consisting of 13 pages of text, 15 pages of color name charts (each for a given range of Munsell hue) to be used when one wishes to find the name of a color, and 4 pages showing the same color name boundaries in terms of constant Munsell value (used as the measure of lightness). In the sections that follow (pages 37–82) there is a listing of many thousands of synonymous and near-synonymous color names (together with the color name source) grouped under the 267 designations of the ISCC-NBS method. As the report says, the names Testaceous, Samurai, and Araby all refer to grayish reddish orange colors. In a similar way the meaning of all color names in the many vocabularies included (Ridgway, Maerz and Paul, Plochere, Textile Color Card Association names, and nine others) are defined so that, without reference to an actual color sample, one may have an understandable description of what color the name refers to. Under group 87, moderate yellow, for instance, we find such names as *amber, brass, corn, rattan, yellow smoke, chamois, buff, gold, wheat,* all of which are generally understandable, but we find also in the same group such names as *fustic, giallolino, latoun,*

English pink, bubalinus, lutcolus, electrinus, most of which would not be understood by the average reader, yet they are all "moderate yellows" in the same sense as the first group of words.

The final section (pages 85–158, three colums to a page) is what the authors call the heart of the color names dictionary. It consists of an alphabetical listing of all of the color names studied, each followed by its equivalent ISCC-NBS designations and a key letter denoting its field of application. Synonymous names are indented under the main color names, and the whole is cross-indexed in detail.

In their summary the authors dedicate the method to everyone who has found it difficult to make his color descriptions intelligible, in the hope that it will eventually find such wide use that it will serve as a common denominator in the varied color terminology used in science, art, and industry. To this hope I breathe a fervent amen.

DOROTHY NICKERSON
U.S. Department of Agriculture

Actions Chimiques et Biologiques des Radiations. M. Haissinsky, Ed. Masson, Paris, 1955. 52 pp. F. 2800.

This is the first of an anticipated series to be published on the effects of radiations on matter, both living and nonliving. The volume is divided into three sections: "Aspects physiques de la radiobiologie," by L. H. Gray; "Chemie de radiations des solutions aqueuses. Aspects actuels des resultats expérimentaux," by M. Lefort; and "Modern trends in radiation biochemistry," by W. M. Dale.

L. H. Gray presents in a very readable fashion the fundamental concepts of radiation interaction with matter, from soft x-rays to supervoltage x-rays and gamma rays as well as neutrons and heavy charged particles. Methods and reliability of dosimetry are discussed. For many of the subjects discussed, biological data related to the subject are given. Lefort presents a well-organized account of present knowledge of the radiation chemistry of aqueous solutions. The last chapter on oxidation of organic compounds should be interesting to the radiobiologist. Dale, in his concluding chapter, shows the application of the fundamental principles discussed by Gray and Lefort in modern radiobiology. The indirect action of radiation is discussed progressing from the molecular level through living cells to the whole animal.

This volume is exceedingly well organized, with enough overlapping to make the transition very smooth from chapter to chapter. This volume, along with the other anticipated volumes, should be a real aid to the teacher as well as research worker in this field. The editor and authors should be congratulated on the publication of this collection.

GEORGE E. STAPLETON
Biology Division,
Oak Ridge National Laboratory

Radiocarbon Dating. Willard F. Libby. University of Chicago Press, Chicago, ed. 2, 1955. ix + 175 pp. Illus. $4.50.

The first edition of this important book by the developer of the carbon-14 method of dating was published in 1952. The second, revised edition describes subsequent improvements in the measurement technique and also includes a detailed list of the dates obtained in the author's laboratory prior to the fall of 1954.

These dates, which occupy more than one-third of the text, number 356. Thirty-four relate to Egypt, the Near East, and Western Asia, 34 to Western Europe, 217 to the United States, Canada, and Alaska, 22 to Mexico and Central America, 20 to South America, 27 to various other areas (Manchuria, Japan, Hawaii, Oceania, and Africa), and 2 to tree-ring samples. Many of the dates will be of interest only to professional archeologists; but some are undoubtedly of more general interest. Thus, the famous Florisbad skull from Orange Free State, South Africa, is dated as older than 41,000 years; the Folsom culture at Lubbock, Texas, at 9883 ± 350 years; the first phase of Stonehenge at 3798 ± 275 years; the Dead Sea scrolls at 1917 ± 200 years; and the prehistoric city of Zimbabwe, in South Rhodesia, is given a date of A.D. 574 ± 107 on the Christian calendar.

A chapter on the significance of radiocarbon dates by Frederick Johnson, an archeologist, has been revised and expanded. Johnson observes that where various sorts of evidence, archeological and/or geological, lead to real conclusions concerning chronology, the radiocarbon dates are in general agreement; the major difficulties involve situations where archeologists or geologists do not agree among themselves. He thinks that the results of the carbon-14 dating method are, in general, sound, and that—barring mistakes by collectors and laboratory workers—most of the errors can be traced to the process of selection and collection of samples.

Libby's book will undoubtedly appeal to a varied audience. But it is a "must" for those, such as archeologists and anthropologists, who are particularly concerned with the dating of prehistoric remains and artifacts.

WILLIAM L. STRAUS, JR.
The Johns Hopkins University

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, *but to the publisher or agency sponsoring the publication.)*

Society of Biological Chemists, India, Silver Jubilee Souvenir, 1955. The Society, Bangalore, India, 1955. 262 pp. $3.

The Institute of International Education, 1955 Annual Report. The Institute, New York, 1956. 48 pp.

Prenatal and Paranatal Factors in the Development of Childhood Behavior Disorders. Martha E. Rogers, Abraham M. Lilienfeld, Benjamin Pasamanick. Johns Hopkins University Press, Baltimore, Md., 1955. 157 pp.

Preliminary Report on Financial Protection against Atomic Hazards. Arthur W. Murphy *et al.* Atomic Industrial Forum, Inc., New York, 1956. 37 pp.

Sand Variation at Point Reyes Beach, California. Tech. Memo. No. 65. 1955. 86 pp. *Factors Affecting the Economic Life of Timber in Coastal Structures.* Tech. Memo. No. 66. 1955. 23 pp. *A Model Study of the Run-Up of Wind-Generated Waves on Levees with Slopes of 1:3 and 1:6.* Tech. Memo. No. 67. 1955. 19 pp. *Wave Action and Sand Movement near Anaheim Bay, California.* Tech. Memo. No. 68. 1956. 21 pp. Beach Erosion Board, Office of Chief of Engineers, Washington 25.

The National Formulary 1955, First Amendment 1956. Pharmaceutical Press, London, 1956 (order from Rittenhouse Bookstore, Philadelphia). 6 pp. 6d.

The Effect of Water Impurities on the Flavor of Brewed Coffee. Publ. No. 6. Ernest E. Lockhart, C. L. Tucker, M. C. Merritt. Coffee Brewing Institute, New York, 1956. 11 pp.

Instrumentation and Methods for Radioactivity Detection in the Mineral Industry. Quart. Colorado School of Mines, vol. 51, No. 1. James O. Milmoe and Stephen P. Kanizay. Colorado School of Mines, Golden, 1956. 97 pp. $1.

Studies in Cheremis: the Supernatural. Viking Fund Publ. in Anthropology, No. 22. Thomas A. Sebeok and Frances J. Ingemann. Wenner-Gren Foundation for Anthropological Research, New York, 1956. 357 pp. $5.

Mathematics in an Industrial Economy. Industrial Mathematics Society, Detroit, Mich., 1955. 15 pp.

American Society for Artificial Internal Organs, Transactions. vol. 1. The Society, Los Angeles 29, 1956. 106 pp. $3.

Commercial and International Developments in Atomic Energy. Proceedings of a meeting for members and guests, 27–29 Sept. 1955, Sheraton-Park Hotel, Washington, D.C. Atomic Industrial Forum, New York, 1956. 598 pp. $8.50.

Scientific Meetings

Meeting Notes

■ The spring meeting of the American Physical Society will be held in Washington, D.C., 26–28 Apr. Three hundred and ninety-three contributed papers are distributed among 33 sessions. Last year the number was 394, and the previous year 406.

R. D. Huntoon is for the second time chairman of the local committee. Last-minute correspondence to officers, session chairmen, and members should be addressed in his care, Local Arrangements Committee, Room 112 C, Sheraton Park Hotel.

■ The first Congreso Pan-Americano de Gerontologia will be held under the presidency of Manuel Payno in Mexico City, D.F., 15–22 Sept. This is a week later than was previously announced. Abstracts of not more than 200 words of papers to be presented should be sent to Dr. E. V. Cowdry, Chairman of the North American Committee of Cooperation, Washington University of Medicine, St. Louis 10, Mo.

■ The 1956 annual congress of DECHEMA (Deutsche Gesellschaft fur Chemisches Apparatewesen) will be held in connection with the 9th meeting of the European Federation for Chemical Engineering in Frankfurt am Main, Germany, 6–9 June. The program will feature a series of papers on the "Basic principles of chemical engineering as applied to chemical reactions on a large scale."

■ A world conference on earthquake engineering will be presented jointly by the Earthquake Engineering Research Institute and the University of California, Berkeley, in cooperation with the Structural Division of the American Society of Civil Engineers and the Structural Engineers Association of California on the Berkeley campus 12–16 June.

In addition to marking the 50th anniversary of the San Francisco quake, the conference will have as its specific objectives: (i) review of the development of seismology and earthquake engineering to this time; (ii) presentation of technical papers on aseismic design and construction practices in all of the major seismic areas of the world; and (iii) meeting of the world's seismologists and structural engineers to create a closer liaison among the many groups concerned with the earthquake problem. Inquiries should be addressed to the Department of Conference and Special Activities, University Extension, University of California, Berkeley 4, Calif.

■ The International Congress of Clinical Chemistry will be held from 9–14 Sept. 1956 at the Barbizon Plaza, New York, instead of at the Hotel New Yorker, as previously announced. A program of special events is being planned for associate members during the week. For the congress itself, the following scientific program has been tentatively arranged by Harry Sobotka:

10 Sept.

Symposium on blood electrolytes, to be opened by D. D. van Slyke with a tribute to the late John Peters as a pioneer in clinical chemistry. C. P. Stewart (Edinburgh) and Margaria (Milan) will speak on various phases of blood electrolytes analysis. Possibly Wettstein (Basle) and Josephson (Stockholm) will speak on blood electrolytes in adrenal and renal physiology respectively.

11 Sept.

Hemoglobin and bile pigment. Speakers: Huisman (Groningen) and Rudi Schmid (Bethesda).

Symposium on standardization. Speakers: Wootton (London), Seligson (Philadelphia), and possibly Sanz (Geneva).

13 Sept.

Enzymes and vitamins. Speakers: E. J. King (London) on enzymes, Nordman (Paris) on citric acid cycle products, and Siliprandi (Rome) on vitamin B complex.

14 Sept.

Symposium on proteins, to be opened by Henley (Washington) with a review of electrophoresis and a tribute to the late Kurt G. Stern. Wuhrmann (Winthertur) will speak on serum proteins, Verschure (Utrecht) on lipoproteins, and Maclagan (London) or Stary (Istanbul) on mucoproteins.

Other sessions will be devoted to contributed papers on the same or different subjects, if necessary in parallel sessions.

■ The 12th congress of the International Union of Forest Research Organizations will be held in Oxford, England, 7–14 July, followed by a choice of one of 8 week-long study tours in England, Scotland, and Wales. The congress succeeds the fifth general assembly of the International Union for the Protection of Nature, which is to be held in Edinburgh, Scotland, 20–28 June. Participants should arrive in Oxford on the evening of 6 July.

The meetings of the Congress will consist of plenary sessions and meetings of the different subject-matter sections. No papers will be read, but there will be discussion of preprinted papers in each field.

The union consists of public and private forest experiment stations, university schools of forestry, and institutes. There are also a few individual members. Congresses are held at 4-year intervals.

Some of the chief activities in the past have been the preparation of a forest bibliography and system for classification of forestry literature, standardization of methods of forest-site description and calculation of forest yields, experiments in the influence of seed source on growth and development of leading commercial species, standardization of methods of seed-testing and certification, and many similar projects.

Attendance at the Oxford congress is open to all interested persons. Further information may be obtained from the secretary of the organizing committee, Mr. B. V. Mills, Forestry Commission, 25 Saville Row, London W1, England, or from Mr. Henry I. Baldwin, Hillsboro, N.H.

■ The annual session of the Colloquium of College Physicists will take place at the State University of Iowa, 13–16 June. Special attention will be given to the upper atmosphere, cosmic rays, the solid state, recruitment of the profession, an exhibit, new equipment designs, new methods, undergraduate group presentations, and recent publications. The featured lecture series, consisting of four lectures, will be given by Norman F. Ramsey of Harvard University.

■ The ninth annual microbiological institute will be held 4–9 June at Purdue University under the direction of C. L. Porter of the department of biological sciences. Sessions will be devoted to lectures, laboratory exercises, and demonstrations to teach the characteristics of the fungi of greatest importance in industry. Emphasis will be placed on techniques that will result in rapid identification.

The following evening lectures are scheduled: "Social implication of sex in micro-organisms," Edward D. De-

Lamater, School of Medicine, University of Pennsylvania; "Use of antibiotics in food preservation," F. E. Deatherage, department of agricultural biochemistry, Ohio State University; "Fungi in Relation to the paper industry," Elwood O. Dillingham, Institute of Paper Chemistry, Appleton, Wis.; "The nature of some imperfect fungi of industrial importance," H. L. Barnett, department of mycology, West Virginia University; "Research possibilities in the fermentation industries," J. E. McClary, director of Brewing Research, Anheuser-Busch, Inc., St. Louis, Mo.

■ "Earth satellites as research vehicles" was the topic of a symposium that was held at the Franklin Institute, Philadelphia, Pa., on 13 Apr. The meeting was another one of the succession of events in celebration of the 250th anniversary of the birth of Benjamin Franklin.

The speakers who presented papers were George H. Clement of the Engineering Division, Rand Corporation, Santa Monica, Calif.; Krafft A. Ehricke of the Preliminary Design and Systems Analysis Group, Convair Division, General Dynamics Corporation, San Diego, Calif.; Lovell Lawrence, Jr., of the Power Plant Design Missile Operations, Chrysler Corporation, Detroit, Mich.; Homer E. Newell, Jr., Rocket-Sonde Research Board, Naval Research Laboratory, Washington, D.C.; R. W. Porter, chairman, Panel on Earth Satellite, IGY, General Electric Company, New York; and Lyman Spitzer, Jr., director Princeton University Observatory, Princeton, N.J.

■ Stanford Research Institute and the University of California will sponsor jointly a symposium on "High temperature—a tool for the future" at the university's Berkeley campus, 25–27 June. More than 300 scientific and industrial people are expected to attend the discussions of high-temperature methods, materials, and processes in science and industry. Address inquiries to Dr. Nevin K. Hiester, Chemical Engineering Section, Stanford Research Institute, Menlo Park, Calif.

Society Elections

■ University of Pittsburgh, Association of Geology Teachers: pres., Stanard Bergquist, Michigan State University; vice-pres., J. Robert Berg, University of Wichita; sec., C. E. Prouty, University of Pittsburgh; treas., Charles G. Higgens, University of California, Davis. Representative to the AAAS Council is Richard M. Foose, Franklin and Marshall College.

■ Wildlife Society: pres., Durward L. Allen, Purdue University; v.-pres., John S. Gotteshalk, Fish and Wildlife Service, Washington, D.C.; sec.-treas., Daniel L. Leedy, Fish and Wildlife Service, Washington, D.C.

■ Scientific Manpower Commission: pres., John S. Nicholas; v.-pres., B. R. Stanerson; secy.-treas., Glen Finch.

Forthcoming Events

May

16–18. European Assoc. of Exploration Geophysicists, 10th meeting, Hamburg, Germany. (Secretariat, 30 Carel Van Bylandtlaan, The Hague, Netherlands.)

18–26. World Cong. on Fertility and Sterility, 2nd, Naples, Italy. (C. D. Guerrero, Melchor Ocampo 487, Mexico, D.F. Mexico.)

19–20. Population Assoc. of America, annual, Ann Arbor, Mich. (H. Carter, National Office of Vital Statistics, Public Health Service, Washington 25.)

20–22. Building Research Inst., 5th annual, Niagara Falls, Ontario, Canada. (W. H. Scheick, BRI, 2101 Constitution Ave., Washington 25.)

20–22. International Cong. of Neo-Hippocratic Medicine, Montecatini Terne, Italy. (Dr. Valente, 41 Av. Verdi, Montecatini, Terme.)

20–24. American Assoc. of Cereal Chemists, New York, N.Y. (C. L. Brooke, Merck & Co., Inc., Rahway, N.J.)

20–25. National Conf. of Social Work, St. Louis, Mo. (22 W. Gay St., Columbus 15, Ohio.)

21–23. American Trudeau Soc., 51st annual, New York, N.Y. (Miss E. Lovell, National Tuberculosis Assoc., 1790 Broadway, New York 19.)

21–24. Air Pollution Control Assoc., Niagara Frontier, annual, Buffalo, N.Y. (H. C. Ballman, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

21–26. International Colloquium on Luminescence of Crystalline Inorganic Substances, Paris, France. (Laboratoire de Luminescence, Faculté des Sciences, Univ. de Paris, 12 Rue Cuvier, Paris 5e.)

23–24. Work Conf. on Radiation-Induced Mutations, Upton, Long Island, N.Y. (S. Shapiro, Brookhaven National Laboratory, Upton, L.I.)

23–25. American Soc. of Mechanical Engineers, Montreal, Quebec. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

23–26. European Symposium on Vitamin B_{12}, 1st, Hamburg, Germany. (H. Bauer, Nervenklinik, Hamburg-Eppendorf.)

23–1. International Cong. of Animal Reproduction, 7th, Madrid, Spain. (European Assoc. for Animal Reproduction, Via Quintino Sella 54, Rome, Italy.)

24–26. International Cong. on Pathology of Infectious Diseases, Lyons, France. (Secretary, Institut Pasteur, Paris.)

24–26. National Soc. of Professional Engineers, Atlantic City, N.J. (P. H. Robbins, 2029 K St., N.W., Washington 6.)

25–27. Soc. for Applied Anthropology, annual, Boston, Mass. (Mrs. E. Purcell, 150 E. 35 St., New York 16.)

26–28. International Cong. of Assoc. for Study of Bronchi, 6th, Brussels, Belgium. (Dr. Maunes, 23 Ave. d'Anderghem, Brussels.)

28–30. Chemical Inst. of Canada Conference, 39th annual, Montreal, Que. (Chemical Inst. of Canada, 18 Rideau St., Ottawa 2, Ont.)

28–1. International Symposium on Venereal Diseases and the Treponematoses, 1st, Washington, D.C. (C. A. Smith, Venereal Disease Program, Div. of Special Health Services, Public Health Service, Washington 25.)

28–2. International Dental Federation, 44th annual, Zurich, Switzerland. (H. Freihofer, 15 Todistrasse, Zurich.)

30–9. International Conf. of Large Electric Systems, 16th, Paris, France. (J. Tribot Laspiere, 112 Blvd. Haussmann, Paris 8e.)

June

3–6. American Soc. of Refrigerating Engineers, Cincinnati, Ohio. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

3–7. Special Libraries Assoc., annual, Pittsburgh, Pa. (Miss M. E. Lucius, 31 E. 10 St., New York 3.)

3–8. Soc. of Automotive Engineers, summer meeting. Atlantic City, N.J. (Meetings Div., SAE, 29 W. 29 St., New York 18.)

4–7. Forest Products Research Soc., Asheville, N.C. (F. J. Rovsek, FPRS, P.O. Box 2010, University Station, Madison 5, Wis.)

4–9. International Mechanical Engineering Cong., 6th, Paris, France. (British Engineers Assoc., 32, Victoria St., London, S.W.1, England.)

4–9. International Seed Testing Convention, Paris, France. (C. Stahl, International Seed Testing Assoc., Thorvaldsensvej 57, Copenhagen V, Denmark.)

4–9. Microbiological Inst., 9th annual, Lafayette, Ind. (Div. of Adult Education, Engineering Administration, Bldg., Purdue Univ., Lafayette.)

6–8. American Soc. for Quality Control, annual, Montreal, Quebec, Canada. (C. E. Fisher, ASQC, Room 563, 50 Church St., New York 7.)

6–9. European Federation for Chemical Engineering, 9th, Frankfurt/Main, Germany. (Dechema-Haus, Rheingau-Allee 25, Frankfurt A.M.)

6–10. American College of Chest Physicians, annual, Chicago, Ill. (M. Kornfeld, ACCP, 112 E. Chestnut St., Chicago.)

7–9. Endocrine Soc., annual, Chicago, Ill. (H. H. Turner, 1200 N. Walker St., Oklahoma City, Okla.)

9–10. Soc. for Investigative Dermatology, annual, Chicago, Ill. (H. Beerman, 255 S. 17 St., Philadelphia 3, Pa.)

10–14. Institute of Food Technologists, annual, St. Louis, Mo. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3, Ill.)

10–15. American Crystallographic Assoc., French Lick, Ind. (S. Siegel, Chemistry Div., Argonne National Lab., Box 299, Lemont, Ill.)

11–15. American Medical Assoc., an-

nual, Chicago, Ill. (G. F. Lull, AMA, 535 N. Dearborn St., Chicago 10.)

11–15. Symposium on Molecular Structure and Spectroscopy, annual, Columbus, Ohio. (H. H. Nielsen, Dept. of Physics, Ohio State Univ., Columbus.)

11–16. Pacific Div., AAAS, Seattle, Wash. (R. C. Miller, California Acad. of Sciences, Golden Gate Park, San Francisco 18.)

11–23. European Organization for Nuclear Research, Symposium on High Energy Physics, Geneva, Switzerland. (H. Coblans, CERN, Case Postale 25, Genève 15-Aéroport.)

12–14. American Meteorological Soc., Seattle, Wash. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

12–15. Max Planck Soc. for Advancement of Sciences, Stuttgart, Germany. (Max Planck Soc., Raiserswerther Str. 164, Düsseldorf 22a, Germany.)

12–16. World Conference on Earthquake Engineering, Berkeley, Calif. (R. W. Clough, Div. of Civil Engineering, Univ. of California, Berkeley 4.)

13–14. Conference for Veterinarians, 25th annual, Columbus, Ohio. (J. W. Helwig, College of Veterinary Medicine, Ohio State Univ., Columbus 10.)

13–16. Colloquium of College Physicists, annual, Iowa City, Iowa. (G. W. Stewart, Dept. of Physics, State Univ. of Iowa, Iowa City.)

16–17. Council of American Bioanalysts, Dallas, Tex. (M. F. Dooley, 308 S. Bishop, Dallas, Tex.)

17–20. American Soc. of Agricultural Engineers, 49th annual, Roanoke, Va. (F. B. Lanham, ASAE, St. Joseph, Mich.)

17–22. American Soc. of Medical Technologists, annual, Quebec, Canada. (Miss R. Matthaei, Suite 25, Hermann Professional Bldg., Houston 25, Tex.)

17–22. American Soc. for Testing Materials, annual, Atlantic City, N.J. (R. J. Painter, ASTM, 1916 Race St., Philadelphia 3, Pa.)

17–23. American Library Assoc., annual, Miami Beach, Fla. (D. H. Clift, 50 E. Huron St., Chicago 11, Ill.)

17–23. World Confederation for Physical Therapy, 2nd international cong., New York, N.Y. (Miss M. Elson, American Physical Therapy Assoc., 1790 Broadway, New York 19.)

17–23. World Power Conf. (invitational), 5th plenary, Vienna, Austria. (S. E. Reimel, Engineers Joint Council, 29 W. 39 St., New York 18.)

17–30. West Coast Science Teachers Summer Conf., Corvallis, Oreg. (R. H. Carleton, National Science Teachers Assoc., 1201 16 St., NW, Washington 6.)

18–20. American Soc. of Heating and Air-Conditioning Engineers, Washington, D.C. (A. V. Hutchinson, ASHAE, 62 Worth St., New York 13.)

18–21. Institute of Aeronautical Sciences, Inc., annual summer, Los Angeles, Calif. (S. P. Johnston, 2 E. 64 St., New York 21.)

18–21. Phi Lambda Upsilon, triennium convention, Ann Arbor, Mich. (T. B. Cameron, Dept. of Chemistry, Univ. of Cincinnati, Cincinnati 21, Ohio.)

18–22. American Physical Therapy Assoc., annual, New York, N.Y. (Miss M. Elson, APTA, 1790 Broadway, New York 19.)

18–22. Medical Library Assoc., 55th annual, Los Angeles, Calif. (A. N. Brandon, Library, College of Medical Evangelists, Loma Linda, Calif.)

18–24. Acoustical Soc. of America, Cambridge, Mass. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

19–22. American Dairy Science Assoc., annual, Storrs, Conn. (H. F. Judkins, 32 Ridgeway Circle, White Plains, N.Y.)

20–21. Symposium on Diffusion and Flow Processes in Polymers, Madison, Wis. (W. J. Lyons, Quartermaster Research and Development Command, Natick, Mass.)

20–22. American Assoc. of Physics Teachers, annual, Toronto, Ont., Canada. (F. Verbrugge, Carleton College, Northfield, Minn.)

20–28. International Union for the Protection of Nature, Edinburgh, Scotland. (J. P. Harroy, IUPN, 42, rue Montoyer, Brussels, Belgium.)

21–23. American Physical Society, New Haven, Conn. (K. K. Darrow, Columbia Univ., New York 27.)

21–23. American Physical Society, Eugene, Ore. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

21–23. Soc. of Nuclear Medicine, annual, Salt Lake City, Utah. (R. G. Moffat, 2656 Heather St., Vancouver 9, Canada.)

21–24. American Acad. of Dental Medicine, 10th annual, Detroit, Mich. (G. J. Witkin, AADM, 45 S. Broadway, Yonkers 2, N.Y.)

21–24. American Soc. of Ichthyologists and Herpatologists, 36th annual, Higgins Lake, Mich. (R. M. Bailey, Museum of Zoology, Univ. of Michigan, Ann Arbor.)

25–27. Symposium on Uses of High Temperatures in Science and Industry, Berkeley, Calif. (N.K. Hiester, Stanford Research Inst., Menlo Park, Calif.)

25–29. American Soc. for Engineering Education, annual, Ames, Iowa. (W. Leighton Collins, Univ. of Illinois, Urbana.)

25–29. American Inst. of Electrical Engineers, Summer and Pacific General, San Francisco, Calif. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

25–29. Alpha Chi Sigma Fraternity, biennial convention, University Park, Pa. (J. R. Kuebler, 5503 E. Washington St., Indianapolis 19, Ind.)

25–29. International Cong. on Physio-Pathology of Animal Reproduction and of Artificial Insemination, 3d, Cambridge, England. (J. Edwards, Production Div., Milk Marketing Board, Thames Ditton, Surrey, England.)

25–30. International Assoc. for Bridge and Structural Engineering, 5th cong., Lisbon, Portugal. (M. L. Gretner, Swiss Federal Inst. of Technology, Zurich.)

26–29. American Home Economics Assoc., annual, Washington, D.C. (Miss M. Horton, AHEA, 1600 20 St., NW, Washington 9.)

28–1. International Scientific Conf. of Rheumatism, Aix-les-Bains, France. (M. Graber-Duvernay, 6, rue de Liege, Aix-les-Bains.)

July

1–7. International Conf. on Nuclear Reactions, Amsterdam, Netherlands. (S. A. Wouthuysen, Zeeman Laboratorium, Pl. Muidergracht 4, Amsterdam (C).)

1–7. National Education Assoc., Portland, Oreg. (W. G. Carr, NEA, 1201 16 St., NW, Washington, D.C.)

2. Astronomical League, Miami, Fla. (W. A. Cherup, 4 Klopfer St., Millvale, Pittsburgh 9, Pa.)

2. Gamma Sigma Delta Biennial Conclave, Ames, Iowa. (J. A. Johnson, Dept. of Flour and Feed Milling Industry, Kansas State College, Manhattan.)

2–3. National Science Teachers Assoc., Corvallis, Oreg. (R. H. Carleton, NSTA, 1201 16 St., NW, Washington 6.)

6–14. International Union of Forestry Research Organizations, 12th cong., Oxford, England. (Secretariat of Union, Viale delle Terme di Caracalla, Rome, Italy.)

9–11. Symposium on Chemical Additives in Foods, 2nd of 5 symposiums, Amsterdam, Netherlands. (H. F. DuPont, International Bur. of Analytical Chemistry, 18 Ave. de Villars, Paris 7, France.)

12–14. International Astrophysical Symposium on Molecules in Cosmic Sources, 7th, Liege, Belgium. (H. C. Urey, Inst. for Nuclear Studies, Univ. of Chicago, Chicago 37, Ill.)

16–21. French Assoc. for the Advancement of Science, Dijon, France. (Mlle. Henri-Martin, Secretary, 28, rue Serpente, Paris 6e.)

17–26. International Soc. of Photogrammetry, 8th cong., Stockholm, Sweden. (P. O. Fagerholm, Bragevägen 8, Stockholm.)

18–20. Soc. for the Study of Development and Growth, annual, Providence, R.I. (M. V. Edds, Jr., Brown Univ., Providence 12.)

22–27. International Cong. of Pediatrics, 8th, Copenhagen, Denmark. (Prof. Franconi, Kinderspital, Steinwiesstrasse 75, Zürich 32, Switzerland.)

22–28. International Cong. on Housing and Town Planning, Vienna, Austria. (H. van der Weijde, International Federation for Housing and Town Planning, Paleisstraat 5, The Hague, Netherlands.)

22–28. International Cong. of Radiology, 8th, Mexico, D.F., Mexico. (J. Noriega, Tepic 126, 2° piso, Mexico, D.F. 7.)

23–26. International Cong. of Developmental Biology, 1st, Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

26–28. International Conf. on Biochemical Problems of Lipids, 3rd, Brussels, Belgium. (R. Ruyssen, St. Jansvest 12, Univ. of Ghent, Ghent, Belgium.)

27–31. Symposium on Cytodifferentiation (invitational), Providence, R.I. (J. W. Wilson, Dept. of Biology, Brown Univ., Providence.)

27–7. International Limnology Cong., 13th, Helsinki, Finland. (H. Luther, Snellmansgatan 16 C 36, Helsinki.)

30–4. International Physiological Cong., 20th, Brussels, Belgium. (J. J. Reuse, Faculté de Medecine, 115 Boulevard de Waterloo, Brussels.)

Equipment News

■ CHROMATOGRAPHY CATALOG by Schaar features complete listings of equipment, accessories, and chemicals currently being used in chromatographic analysis. New catalog items shown for the first time include tube set-ups, fraction collectors, electric desalter, solvents, chemical absorbents and ion exchangers, distillograph and chromatogram attachments for spectrophotometers. (Schaar and Co., Dept. Sci., 754 W. Lexington St., Chicago 7, Ill.)

■ VERTICAL FORCE MAGNETOMETER model A-2, a Schmidt-type magnetic balance for precise measurement of the vertical magnetic field intensity of the earth, can be used to trace favorable ore formations in drift-covered areas or as a direct guide to favorable ore locations in the absence of rock outcroppings. The magnetometer has a permanently attached compass. It has a sensitivity of 15 gammas per scale division and an intensity range of 0 to 15,000 gammas. The balance system utilizes permanent magnets of a newly developed alloy to insure high sensitivity and stability. The instrument is supplied with temperature compensator, specially constructed tripod for operation in soft snow and muskeg, auxiliary magnets and magnet holder, carrying case and the necessary adjustment tools. (Radiac Company, Inc., Dept. Sci., 489 Fifth Ave., New York.)

■ STEEL PUMP PLATE designed for experimental vacuum evaporations is useful for experimental evaporation and sputtering of metals, multilayer coatings, vacuum melting of metals, and vacuum impregnation. The plate measures 17 in. in diameter by ¾ in. in thickness and is ground to precision tolerances on the upper surface. Eight holes are provided for feed throughs and accessories. (Central Scientific Co., Dept. Sci., 1700 Irving Park Road, Chicago, Ill.)

■ ORGANIC CHEMICALS recently added to the Eastman list include the following: maleo-pimaric acid; *m*-bromo-α,α,α-trifluorotoluene; 5-chloro-2-hydroxy-4-methylhexanophenone; di-*n*-hexyl carbonate; 1-ethyl-1-(1-naphthyl)-2-thiourea; α-hydroxy-isobutyric acid; indoline; methyl 2-bromo-*n*-butyrate; 5,6,11,12-tetraphenylnaphthacene; and 2,4,7-trinitro-9-fluorenone. (Distillation Products Industries, Dept. Sci., Rochester 3, N.Y.)

■ PARTITIONER makes automatic qualitative and quantitative analyses of gases and volatile liquids by gas-liquid partition chromatography. The instrument has a 14-ft thermostatted chromatographic column to resolve each mixture into its components, and a built-in automatic integrator simultaneously computes and records a number proportional to the quantity of the component making the peak. The instrument is designed for identification of hard-to-differentiate trace impurities in solvents; on-the-spot analysis of fuels, flue and other plant-effluent gases, mine gases, air pollution, and smog; and quality control of foods, beverages, spices, tobacco, and perfumes. The partitioner, with 0.01- to 0.03-ml samples of liquid or 0.3- to 0.6-ml samples of gas, can be used to make an analysis of a multicomponent system in minutes, whereas distillation would require hours or days. (Fisher Scientific Co., Dept. Sci., 418 Fisher Bldg., Pittsburgh 19, Pa.)

■ MAGNETIC SOUND CAMERA with magnetic sound-on-film is a high-fidelity recording system that makes possible the filming of medical motion pictures with synchronized sound. The film passes through normal picture development and can be played back on any 16-mm magnetic sound projector. The Filmagnetic consists of a twin-head camera recording unit with record and instant-monitor magnet heads, a three-way input amplifier, high-fidelity microphone, complete cables, and self-contained batteries. (Berndt-Bach, Inc., Dept. Sci., 6900 Romaine St., Hollywood 38, Calif.)

■ VACUUM DISTILLATION UNIT gives closely identical results over a wide range of conditions and improves results obtained from ASTM-type vacuum distillations. Made of Pyrex glass, it incorporates all the equipment necessary to perform ASTM method D-1160-52T. The unit was developed by H. S. Meyers and A. T. Kiguchi of C. F. Braun and Co. (Glass Engineering Laboratories, Dept. Sci., 602 O'Neill Ave., Belmont, Calif.)

■ FIELD CULTIVATION KIT for rapid bacteriological analysis of water samples utilizes a membrane filter for removing bacteria from the sample. Provision is made for incubation with a new portable incubator that plugs into the cigarette lighter receptacle of an automobile. The unit will also operate on 110 or 220 v. By means of differential media, colonies of bacteria can be readily observed and identified within a 24-hr period. (Millipore Filter Co., Dept. Sci., Watertown 72, Mass.)

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Biologist, M.S.; research experience, desires biological research position. Box 98, SCIENCE. X

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Microbiologist–Biochemist, Ph.D. Several years' research experience in microbial nutrition and metabolism, laboratory and Pilot plant scale; manometric and tracer techniques, bio-assay, chromatography; presently employed. Box 94, SCIENCE. 13, 20, 27 Apr.; 4 May

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60 Orange Street **Bloomfield, N.J.**

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Entomologists: Positions are available with a major producer of agricultural chemicals for (1) A **Ph.D. entomologist,** 0–3 years' experience, for laboratory program involving screening and evaluation of candidate insecticides and miticides. Includes devising and modifying test procedures. Background in entomology, insect toxicology and physiology and biochemistry desirable. Location Middleport, N.Y. (2) Two **M.S. or B.S. Entomologists,** 0–5 years' experience. One to assist in above program at Middleport, the other to conduct field tests on new pesticides in southeastern U.S. with home-base at Jacksonville, Fla. Write to Research Department, Niagara Chemical Division, Food Machinery and Chemical Corporation, Middleport, N.Y. X

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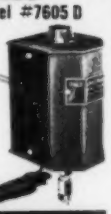

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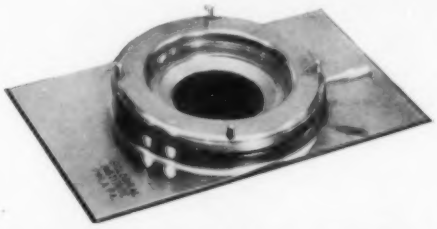

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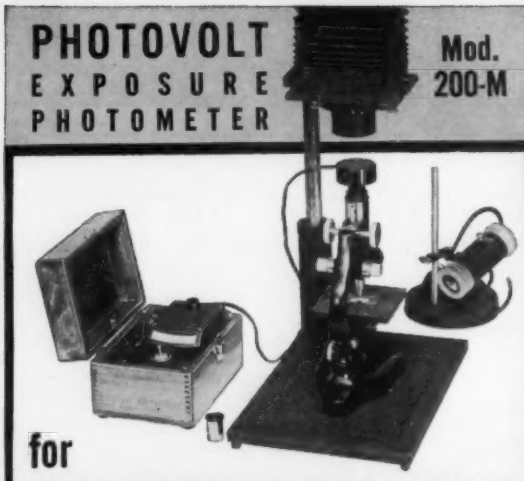

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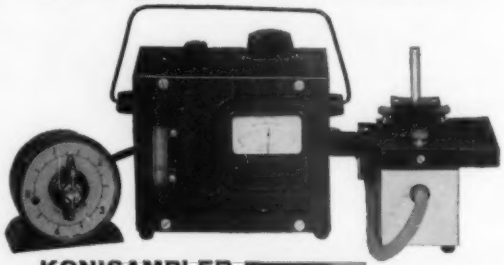

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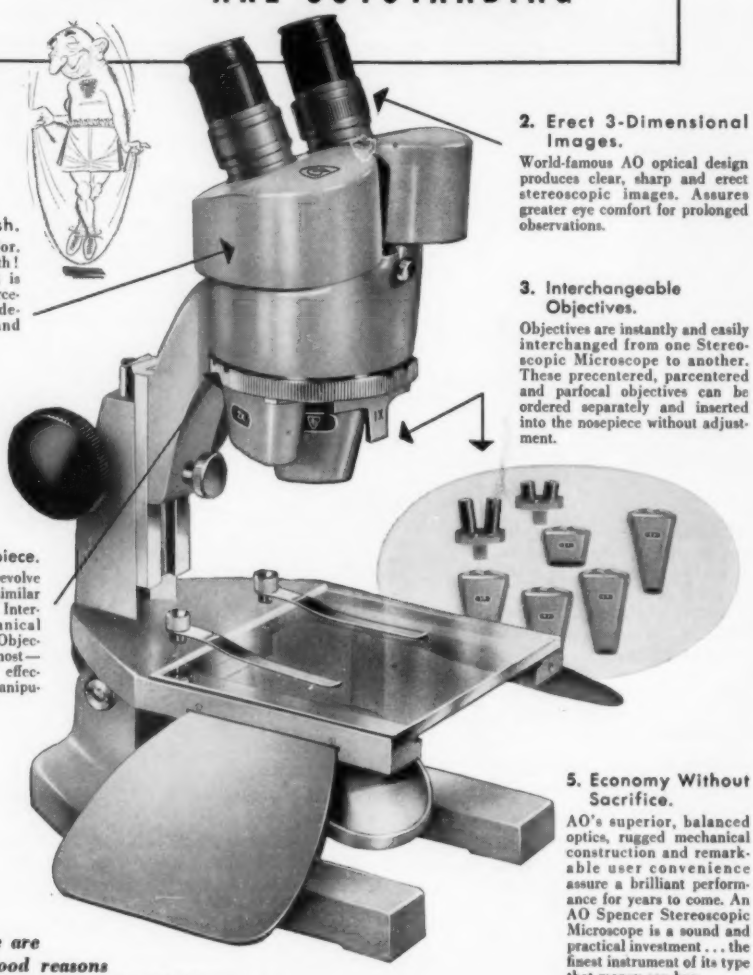

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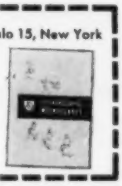
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